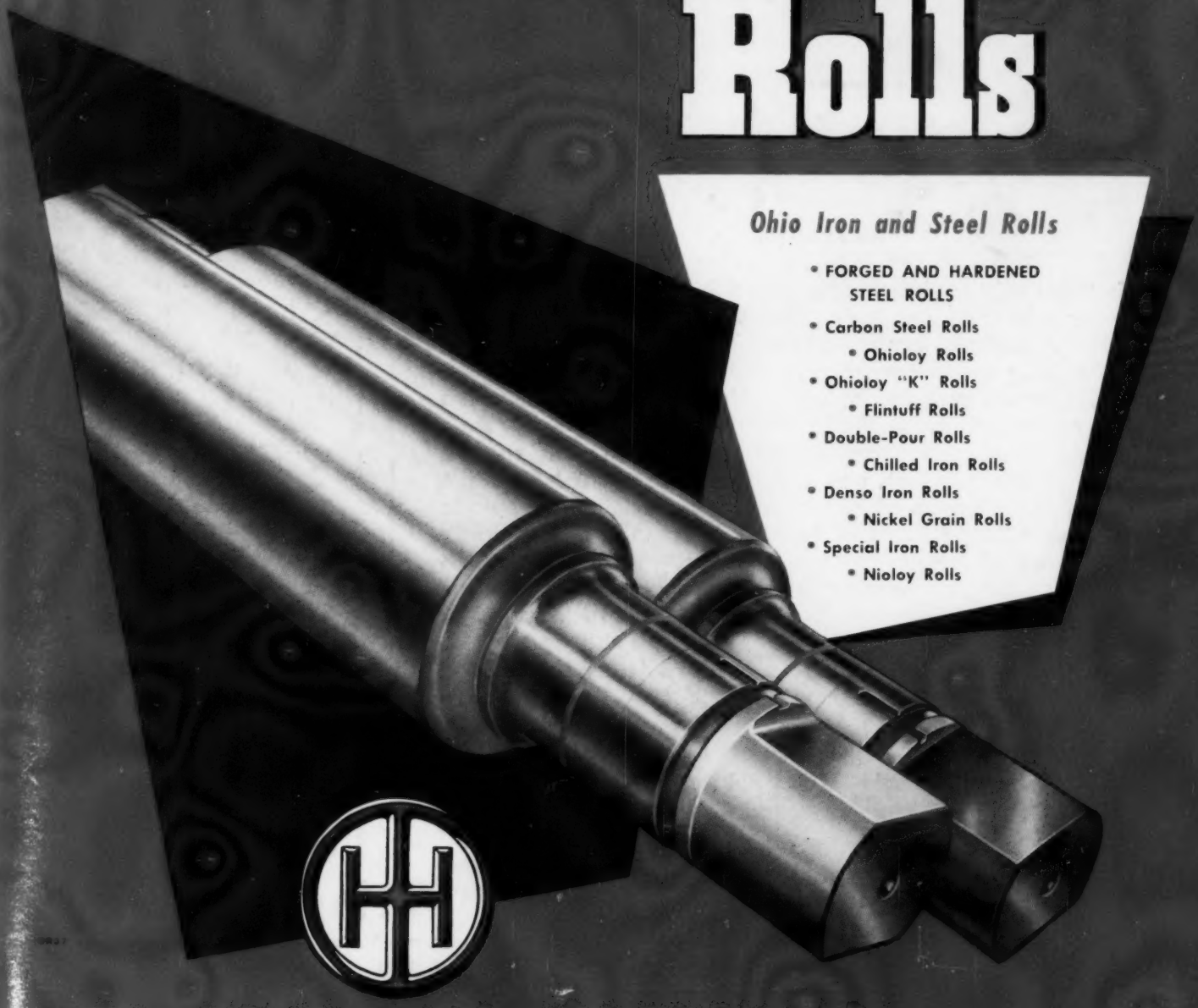
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY, 1960

Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY



Ohio Iron and Steel Rolls

- FORGED AND HARDENED STEEL ROLLS
- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Flintuff Rolls
- Double-Pour Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls

THE OHIO STEEL FOUNDRY CO., LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO... *Virtually at the center of the steel industry*

"How can safety switches wear out? . . . They never seem to be doing anything"

The fact that safety switches seem to be doing nothing at all until an emergency arises and somebody rushes to "pull the switch" is very deceptive. Actually, safety switches *work* every minute they are in service, fighting the ravages of unavoidable internal heating . . . and how well they are built decides how much *safety* your customer has when he really needs it.

Normal full-load current passing through the fuses in a safety switch generates considerable heat, temperatures as high as 700° F are not uncommon. This is not a criticism of fuses because they must operate close to their *melting* point at full load if they are to function properly when an overload occurs. But the continual heating of the switch mechanism in the confined enclosure creates a serious *heat* problem. Metal parts warp and corrode. Contacts loosen, then either weld or *burn up*.

Cutler-Hammer engineers tackled the problem of internal heating and licked it. Cutler-Hammer *Heat-Proof* Safety Switches use only selected heat resistive materials and a design that conducts away the trapped heat. Why settle for less when Cutler-Hammer *Heat-Proof* Safety Switches cost no more. Write today for your handy selection guide, C-H Merchandiser, Pub. EA100-C232. Cutler-Hammer Inc., Milwaukee 1, Wis.

Be sure your men and equipment are protected with *Heat-Proof* Cutler-Hammer Heavy Duty 4105 Safety Switches . . . choice of Mill Engineers everywhere.

CUTLER-HAMMER CONTROL C-H

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • *Division:* **Airborne Instruments Laboratory.** • *Subsidiary:* **Cutler-Hammer International, C. A.**

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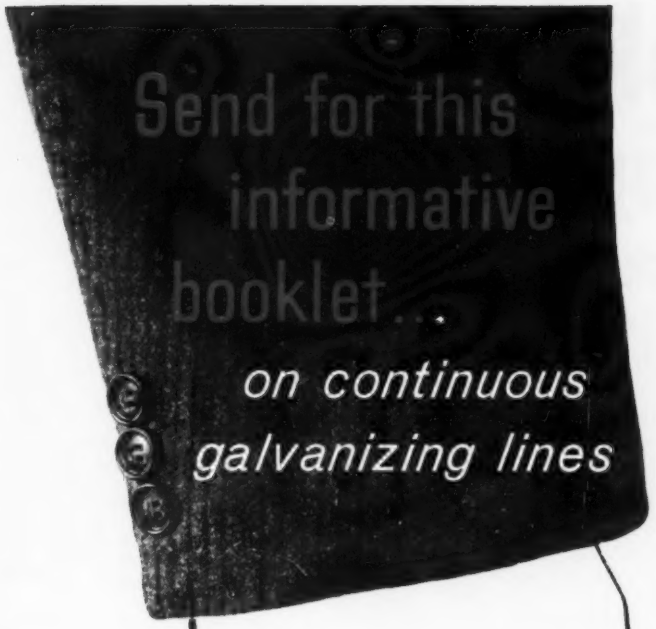

What makes the difference between one galvanizing line and another? How can you save money on the purchase of a Continuous Galvanizing Line? What are the different components that must be considered in the designing of a line?

Aetna-Standard answers these and other questions in this new booklet on Continuous Galvanizing Lines. Other information includes information on the number of lines operating in the world; and pictures of different components of Continuous Galvanizing Lines.

A copy will be mailed promptly upon receipt of your request. BLAW-KNOX COMPANY, Aetna-Standard Division, Pittsburgh, Pennsylvania.

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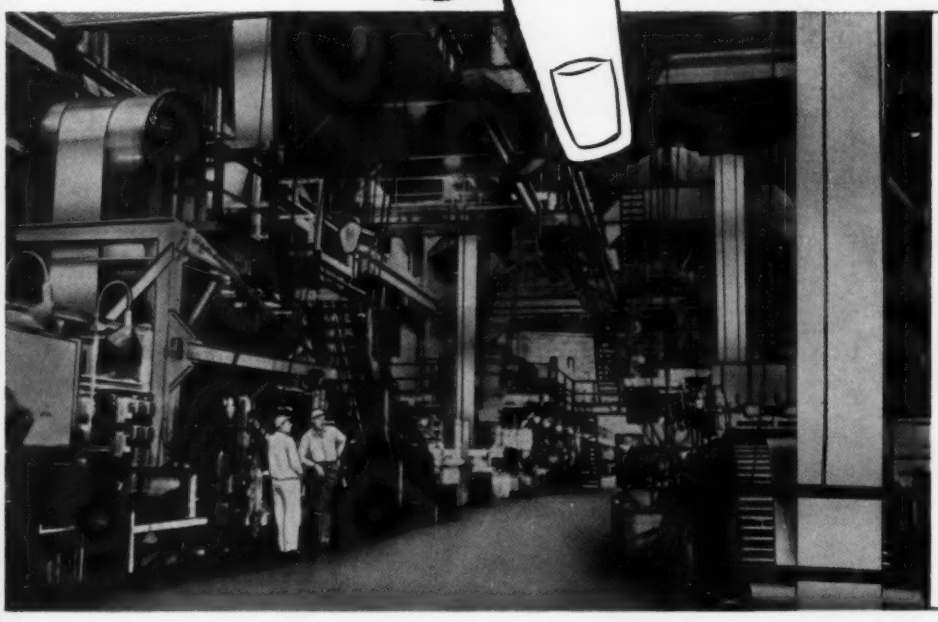

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WORLD'S
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DESIGNER
AND BUILDER
OF CONTINUOUS
GALVANIZING
LINES

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Sound design, solid construction

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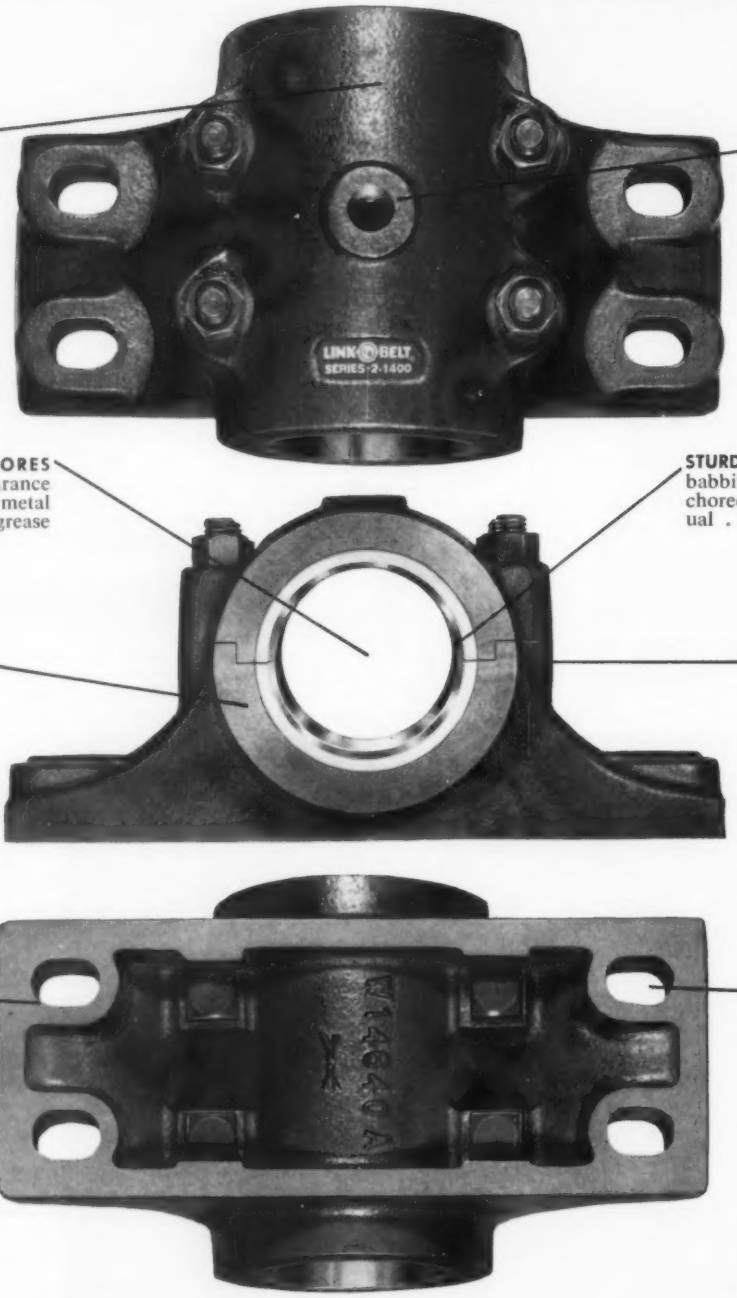
LINK-BELT BABBITTED AND BRONZE BEARING BLOCKS



STURDY, COMPACT HOUSINGS of cast gray iron or cast steel provide exceptional strength where needed, without excess size or weight.

RELIABLE LUBRICATION — Holes for grease cups or pressure fittings are drilled and tapped. Grooves distribute lubricant over entire shaft surface.

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STURDY BEARINGS of heavy-duty babbitt or quality bronze are anchored to housing. Wear is gradual . . . no sudden breakdowns!

FINISHED ENDS permit flush mounting of sprockets, pulleys, wheels and collars against bearing.

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SLOTTED BOLT HOLES in base permit easy adjustment for accurate shaft alignment.

NEW DATA BOOK 2707 has full information on Link-Belt's complete line of babbitted and bronze bearing blocks and takeups. Link-Belt offers off-the-shelf delivery on more than 15 types and over 300 sizes of solid, split, gibbed or angle pillow blocks . . . for commercial shafting up to 12″ diameter. Also immediate delivery on flanged blocks and takeups in all popular sizes. For your copy of Book 2707, contact your nearest Link-Belt office or authorized stock-carrying distributor. Refer to the yellow pages of your local telephone directory.

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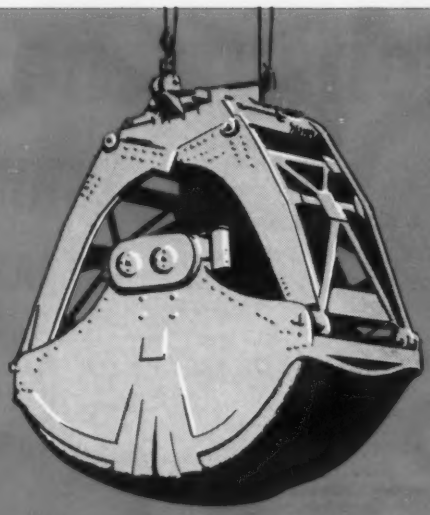
MORE THAN HALF

of the heaviest cranes in American steel mills are built by

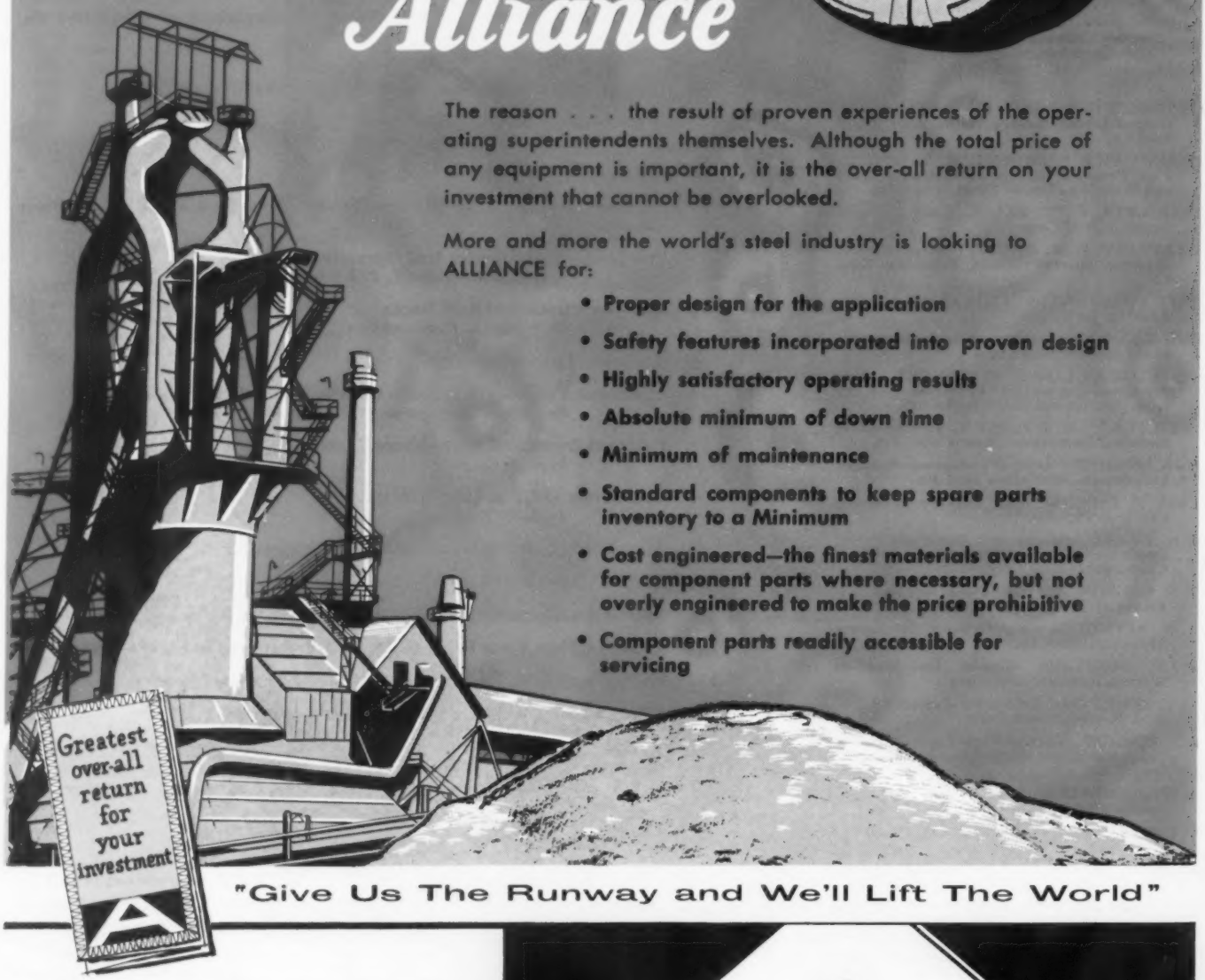
Alliance



The reason . . . the result of proven experiences of the operating superintendents themselves. Although the total price of any equipment is important, it is the over-all return on your investment that cannot be overlooked.

More and more the world's steel industry is looking to ALLIANCE for:

- **Proper design for the application**
- **Safety features incorporated into proven design**
- **Highly satisfactory operating results**
- **Absolute minimum of down time**
- **Minimum of maintenance**
- **Standard components to keep spare parts inventory to a Minimum**
- **Cost engineered—the finest materials available for component parts where necessary, but not overly engineered to make the price prohibitive**
- **Component parts readily accessible for servicing**



"Give Us The Runway and We'll Lift The World"

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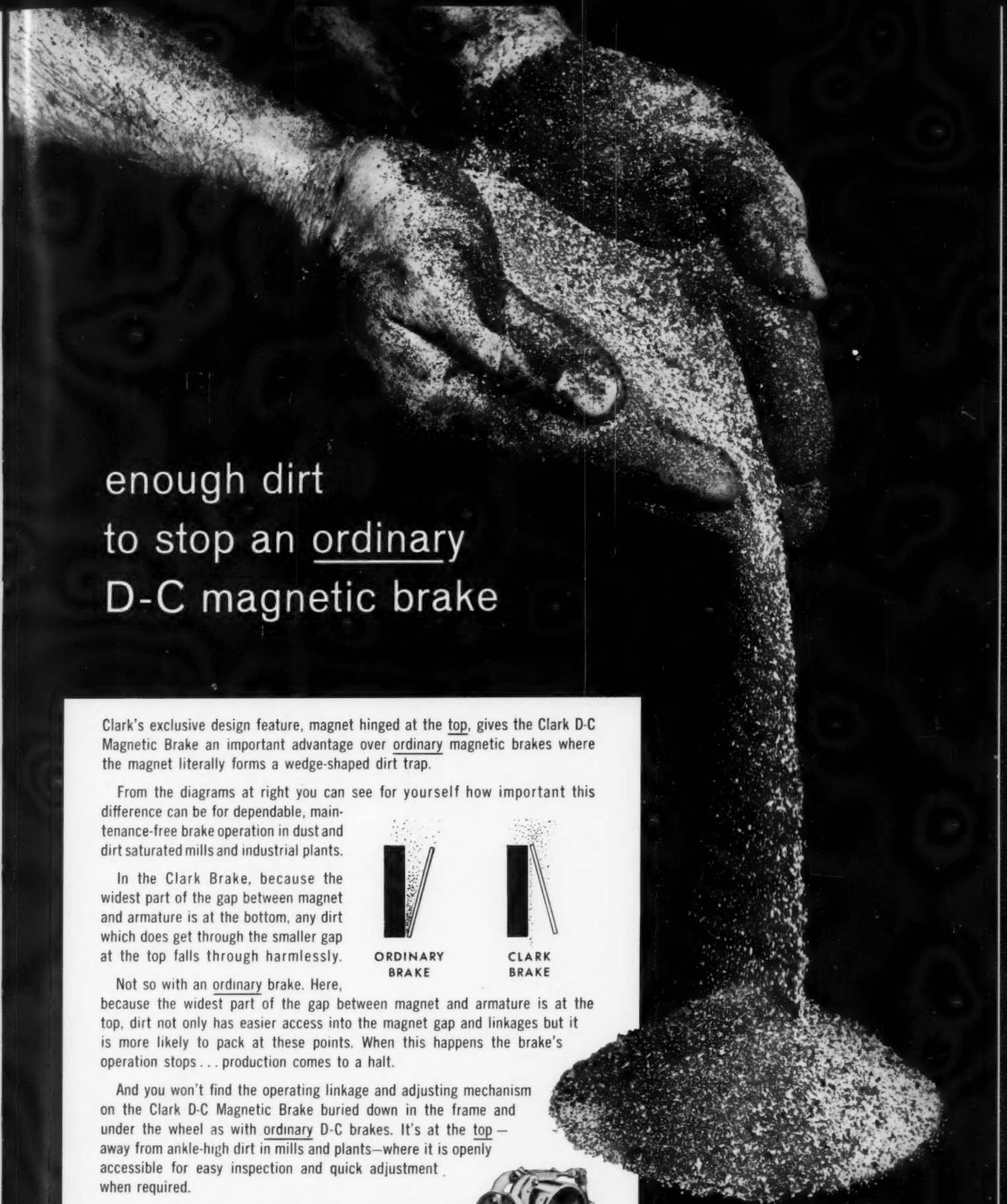
the *Alliance*

machine company

Main Office • Alliance, Ohio



enough dirt to stop an ordinary D-C magnetic brake

Clark's exclusive design feature, magnet hinged at the top, gives the Clark D-C Magnetic Brake an important advantage over ordinary magnetic brakes where the magnet literally forms a wedge-shaped dirt trap.

From the diagrams at right you can see for yourself how important this difference can be for dependable, maintenance-free brake operation in dust and dirt saturated mills and industrial plants.

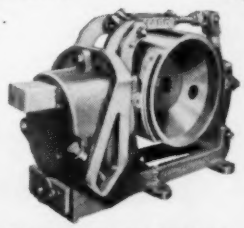
ORDINARY BRAKE

CLARK BRAKE

In the Clark Brake, because the widest part of the gap between magnet and armature is at the bottom, any dirt which does get through the smaller gap at the top falls through harmlessly.

Not so with an ordinary brake. Here, because the widest part of the gap between magnet and armature is at the top, dirt not only has easier access into the magnet gap and linkages but it is more likely to pack at these points. When this happens the brake's operation stops . . . production comes to a halt.

And you won't find the operating linkage and adjusting mechanism on the Clark D-C Magnetic Brake buried down in the frame and under the wheel as with ordinary D-C brakes. It's at the top — away from ankle-high dirt in mills and plants—where it is openly accessible for easy inspection and quick adjustment when required.



For more details on the extraordinary Clark D-C Magnetic Brake see your nearest Clark Controller sales representative. Or write direct to Clark Controller.

9MB1

The
CLARK CONTROLLER
Company

"Everything Under Control"

Main Plant: *Cleveland 10* • **Western Plant:** *Los Angeles 58*
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Results

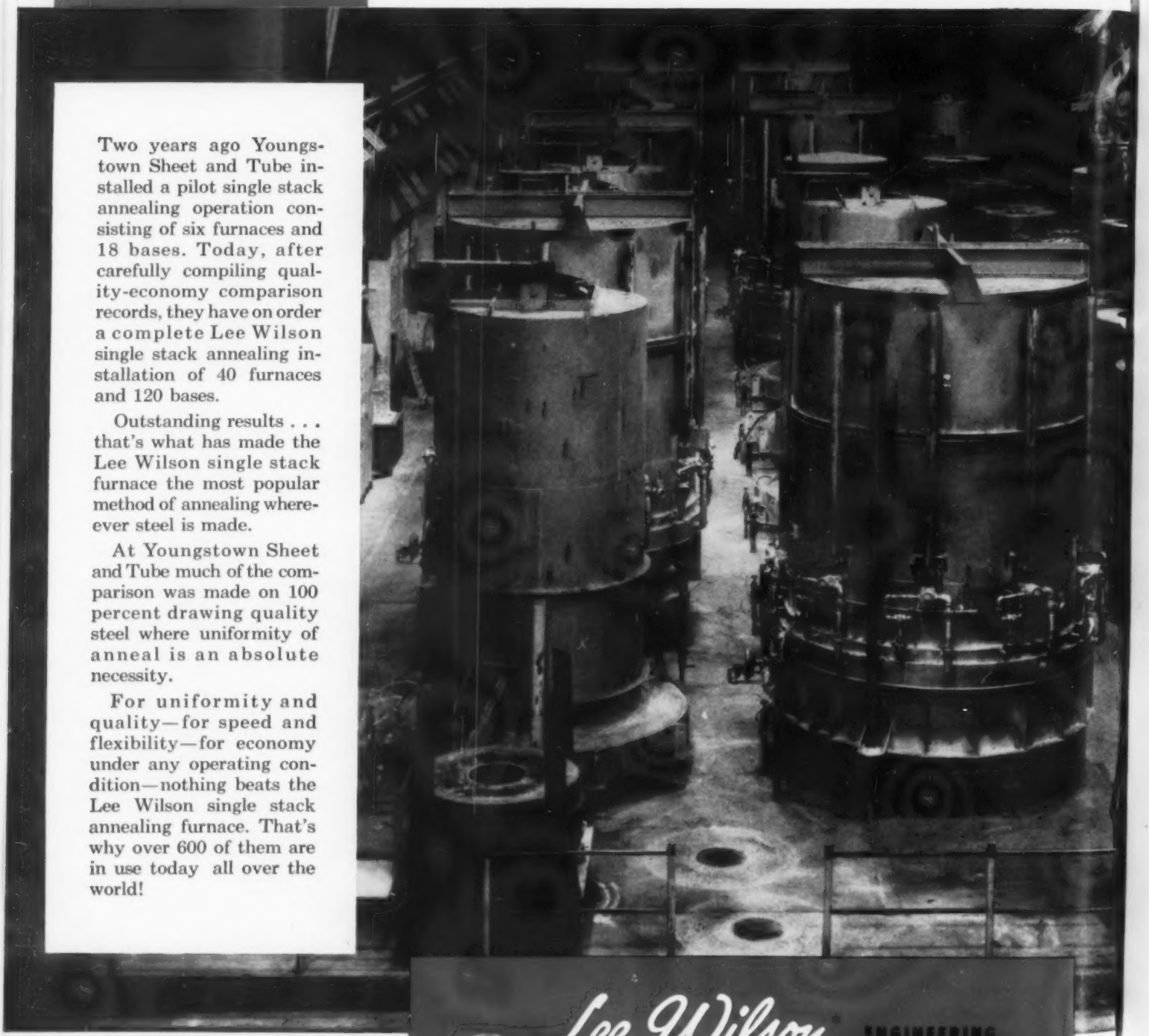
from pilot installation sell Youngstown Sheet and Tube complete 40-furnace Lee Wilson single stack annealing system

Two years ago Youngstown Sheet and Tube installed a pilot single stack annealing operation consisting of six furnaces and 18 bases. Today, after carefully compiling quality-economy comparison records, they have on order a complete Lee Wilson single stack annealing installation of 40 furnaces and 120 bases.

Outstanding results . . . that's what has made the Lee Wilson single stack furnace the most popular method of annealing wherever steel is made.

At Youngstown Sheet and Tube much of the comparison was made on 100 percent drawing quality steel where uniformity of anneal is an absolute necessity.

For uniformity and quality—for speed and flexibility—for economy under any operating condition—nothing beats the Lee Wilson single stack annealing furnace. That's why over 600 of them are in use today all over the world!



Lee Wilson® ENGINEERING COMPANY, INC.

HIGH PRODUCTION ANNEALING SYSTEMS

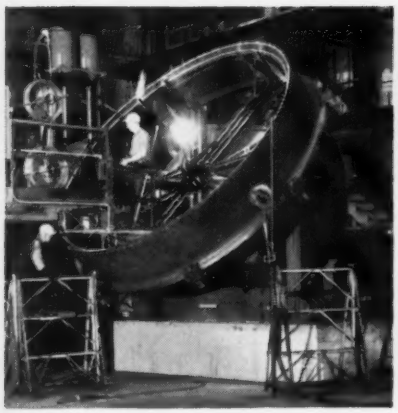
MAKE THE BEST METALS BETTER

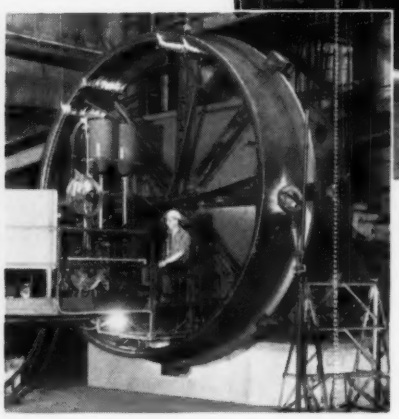
ORIGINATORS AND LEADING PRODUCERS OF OPENED COIL AND SINGLE STACK FURNACES

EXCALIBUR...

Welding Positioner 175 TONS CAPACITY

ARONSON Model G3500 "EXCALIBUR" Gear Driven Positioner is used by a large Eastern steel producer for hard-facing bell hoppers for blast furnaces. "EXCALIBUR" provides the greatest precision and economy in the handling of large workpieces.





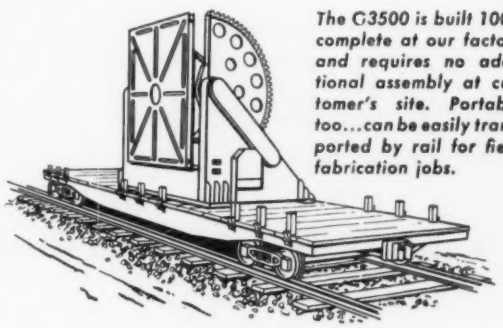
"EXCALIBUR" has been designed to handle almost every kind of weldment at lowest possible shop cost.

"EXCALIBUR" is not physically tremendous, being only 88" from floor to horizontal rotation axis, which allows working both large and small weldments without needing excessive headroom and without working too high above the floor.

"EXCALIBUR" will rotate your weldments as fast as .4 RPM, fast enough for automatic welding down to 8" Dia. and can handle as large a diameter as the factory space permits. It is designed for continuous duty as is encountered when automatic welding hard surfacing jobs where the table may not stop rotating for hours or even for days.

Owning **"EXCALIBUR"** opens production doors to you that are closed to your competitors. It is NOT a special job machine, but a Welding Positioner that will handle 90% of those jobs you now wrestle around the shop floor with the profit-eating crane.

It is quite possible that your capital investment in **"EXCALIBUR"** will be returned in labor and other costs saved in less than three years!



The G3500 is built 100% complete at our factory and requires no additional assembly at customer's site. Portable too...can be easily transported by rail for field fabrication jobs.

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formed to offer the
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Dow Industrial Service will be an organization devoted exclusively to helping you solve maintenance and disposal problems. It will offer an expanded scope of operations designed to be of greater service to all types of industry.

- The new organization will offer the cleaning services proved in plants throughout the U. S. by Dowell during the past 20 years.
- Chemical cleaning personnel will be the same engineers and operators you have known in Dowell.
- Specialized cleaning equipment will be provided from the same stations and offices — located in major industrial areas.
- The research program which has provided many major advances in cleaning techniques and chemicals will be continued — and expanded.

Dow Industrial Service will welcome the opportunity to discuss your cleaning problems on all kinds of equipment in all industries—steam generators, process equipment, heat exchangers, towers, water and product lines, water wells and tanks.

The new organization will also offer consulting services, and a line of chemical products for use in water and waste treatment.

Dowell will continue to offer services and products to the drilling and producing segments of the oil industry.

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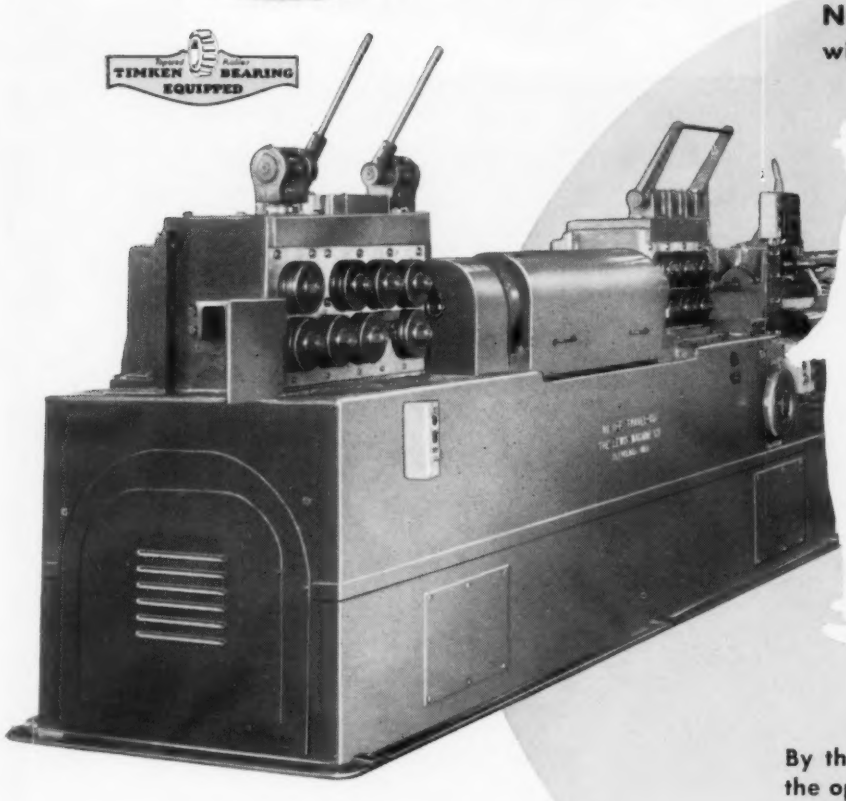
LEWIS

Machines can solve any wire straightening or cutting problems



No. 11-F TRAVEL-CUT
with special extension

This machine was engineered to meet special requirements for custom cutting a wide variety of concrete reinforcing bars up to 50 feet in length

SINGLE STATION OPERATION

eliminates waste time and fatigue by placing operator at one position

By the simple movement of a lever the operator can set the electric limit switch to cut any desired length from 6 to 50 feet. A dial graduated in feet and inches tells him the exact length the machine will cut. A preset counting device stops the machine when the proper number of pieces is cut.

Any predetermined number of pieces may be cut with this equipment to any predetermined length without the operator moving from his regular position at the machine.

There is a Lewis Machine design to straighten and cut all materials and shapes in wire and or bar stock from .012″ to 1″ diameter at a wide range of speeds. If you have a wire straightening and cutting problem, or special requirements for a job, ask us for information and suggestions about how Lewis Machines can increase your production, control your quality and greatly reduce your costs.

New illustrated brochure available on request.

THE LEWIS MACHINE COMPANY

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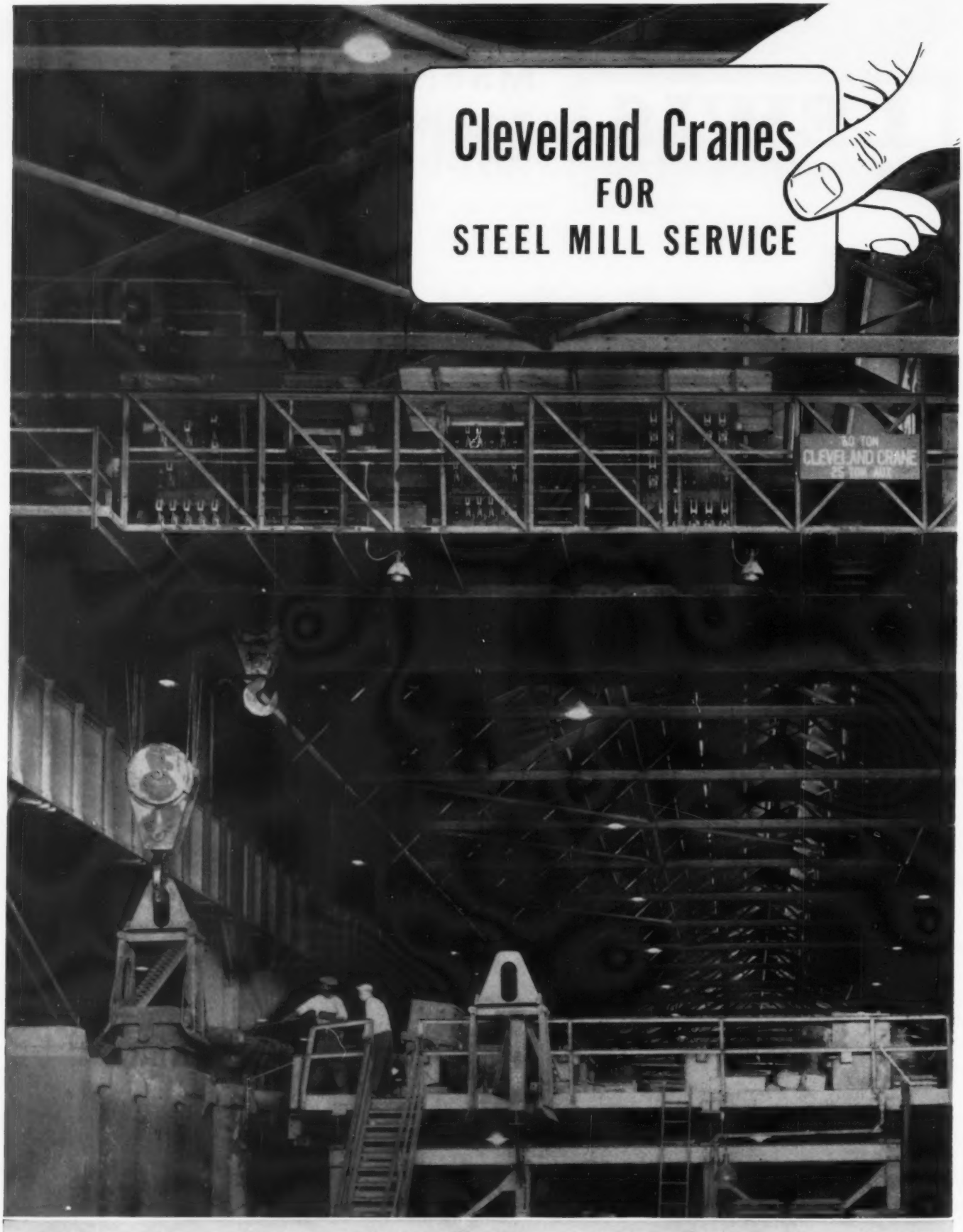

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 E. 289th ST.
WICKLIFFE,
OHIO

Crops *and* Shorts

△ The steel settlement seems to have stirred up more comment than any occurrence in recent years.

It's inflationary.
It's not inflationary.
It's just slightly inflationary.
It's political.
It's not political.
The companies took a shellacking.
It's better for the companies than previous settlements.
It's the result of threats of congessional action.
It's the result of promises to do something about depreciation policy.
It was brought about by Nixon.
It was brought about by Joseph Kennedy.
And we'll doubtless hear more.

Viewing the settlement dispassionately, with its two raises of 10 to 11 cents an hour, 10 to 11 cents for insurance and pension improvement and 7 cents or so for cost of living, we can't say it isn't inflationary. Before the 30-month period of the contract is over, steel prices will be raised. On the other hand, the increase in employment cost is estimated at only between 3 and 4 per cent per year, as compared to the annual 8 per cent resulting from previous contracts.

The settlement is about one-third more than the companies' "last offer." Also, work rules have been relegated to a committee for study. On this basis, the issue could probably have been settled in June without a strike.

We'll probably never know details about such threats and promises as might have been made. Perhaps we should be thankful that the rate of increase in employment costs has been slowed.

△ Now that we're really into the new year and new year's resolutions have pretty much gone by the boards, it's nice to know that we are in the year 5720 A.M. on the Jewish calendar and 1379 A.H. on the Moslem calendar. To the Chinese, it is the year of the Rat.

△ In case you're interested, recent astronomical measurements indicate that our year is gradually lengthening so that, with our present calendar system, we will require an extra leap year day 3000 years from now.

△ The American Iron and Steel Institute estimates that iron and steel companies in the United States expect to spend $1,600,000,000 in 1960 for new equipment and construction. This figure is about 60 per cent above the 1959 expenditure, and is only 10 per cent under the record year, 1957.

△ Through the 14 postwar years, 1946–59, the industry has spent more than $12,000,000,000 to expand and improve its facilities.

△ The Office Economist says that when a man becomes a success, his wife takes most of the credit and the government takes most of the cash.

△ This year marks the 150th anniversary of the invention of the tin can and the development of canning. The field has mushroomed to a point where we now use more than 42,000,000,000 cans a year.

△ At a recent concert in Detroit, about 1000 people paid from $1 to $5 each to listen to a 60-piece orchestra not playing, a 65-voice chorus not singing and 30 musicians playing the Anvil Chorus with rubber mallets.

The program is the culmination of the idea developed by the Hush Label Record Co., an organization founded by two University of Detroit students to manufacture "silent" records for people who crave quiet. Records put out include such titles as The Stony Silence, The Silent Chimes, and Silence to Think By.

The concert, given for the benefit of the University of Detroit chorus, also included some readings on famous pauses from dramatic literature, things left unsaid by great philsophers and legal lapses.

△ According to the American Iron and Steel Institute, U. S. annual steel capacity as of Jan. 1, 1960, totals 148,570,970 net tons, made up of 126,621,630 tons from open hearths, 14,395,940 tons from electric furnaces, 4,157,400 tons from oxygen converters and 3,396,000 tons from bessemer converters.

Blast furnace capacity is set at 96,520,630 net tons of iron per year. Annual coke capacity is 72,309,700 net tons.

△ The office cynic says that women would add years to their lives by simply telling the truth.

△ The Lorain Works of U. S. Steel's National Tube Division broke the all-time steel industry safety record when it passed the mark of 8,260,000 man-hours of production without a lost-time accident. The previous record of 8,241,906 man-hours was set in 1954 by the Johnstown plant of Bethlehem Steel Co.

△ A professor at the University of Wisconsin has developed a cigaret filter which he claims is better than any in use at present. It is composed of one-third charcoal and two-thirds Parmesan Cheese—and then we could save the filters for a cheese omelet.

△ Indicative of the reception the oxygen blown converter is enjoying, present figures show annual capacity to be 4,157,400 tons, with slightly over 9,000,000 tons to come when units now definitely planned are completed. Foreign installations show a present capacity of 7,430,000 tons per year, which will rise to 19,100,000 tons per year upon completion of plants now under construction.

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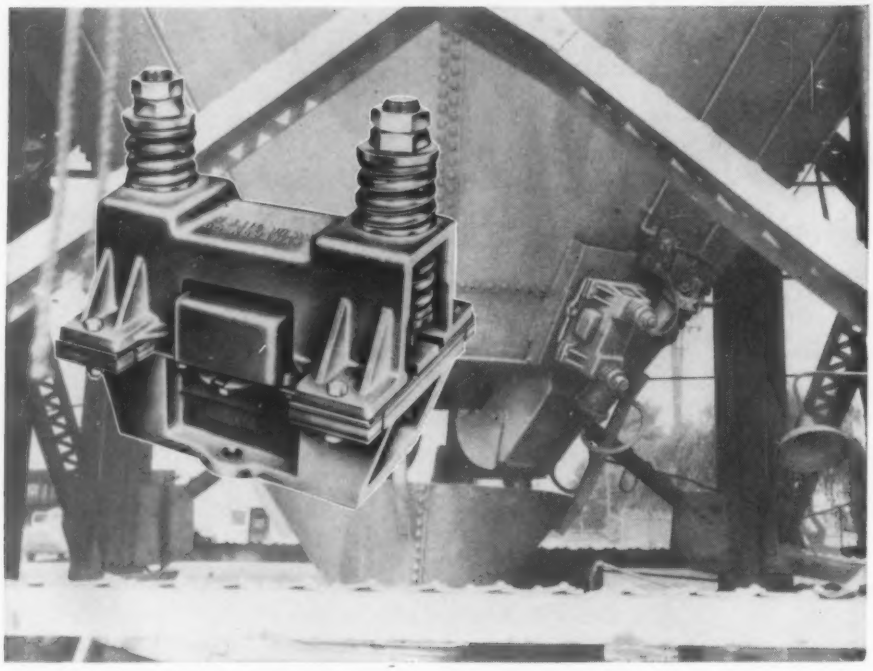

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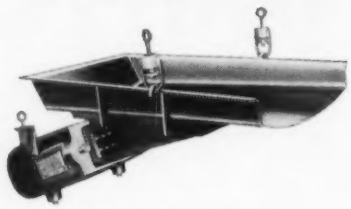

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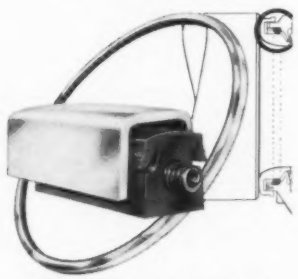

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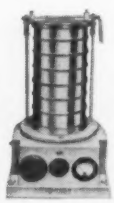

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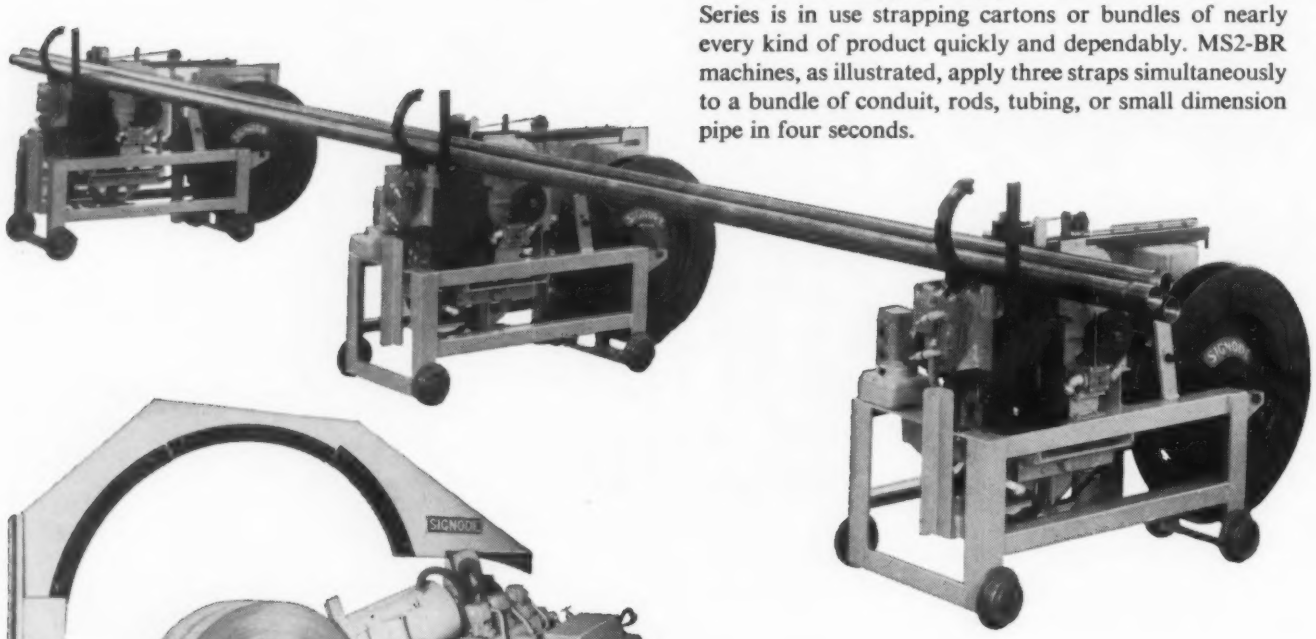

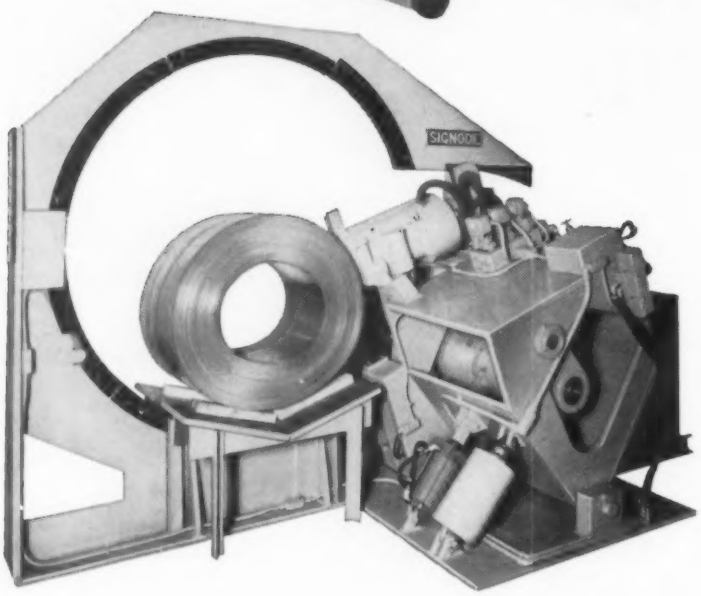

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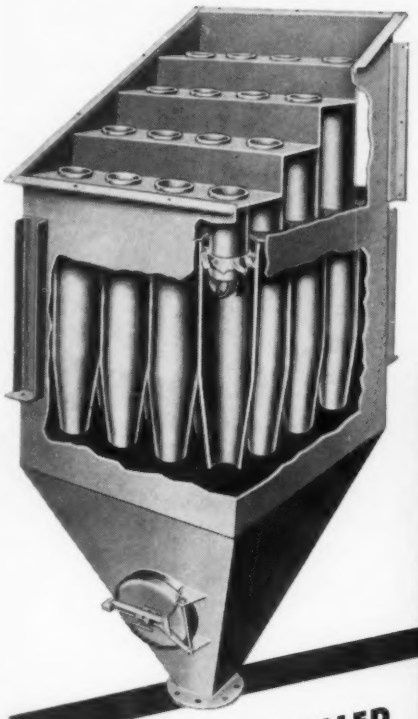

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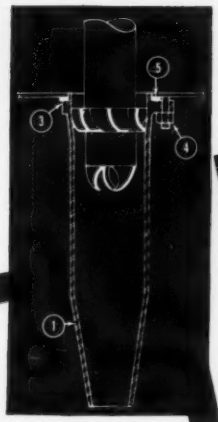

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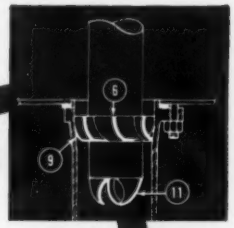

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6. **CAST IRON VANES** resist erosion!
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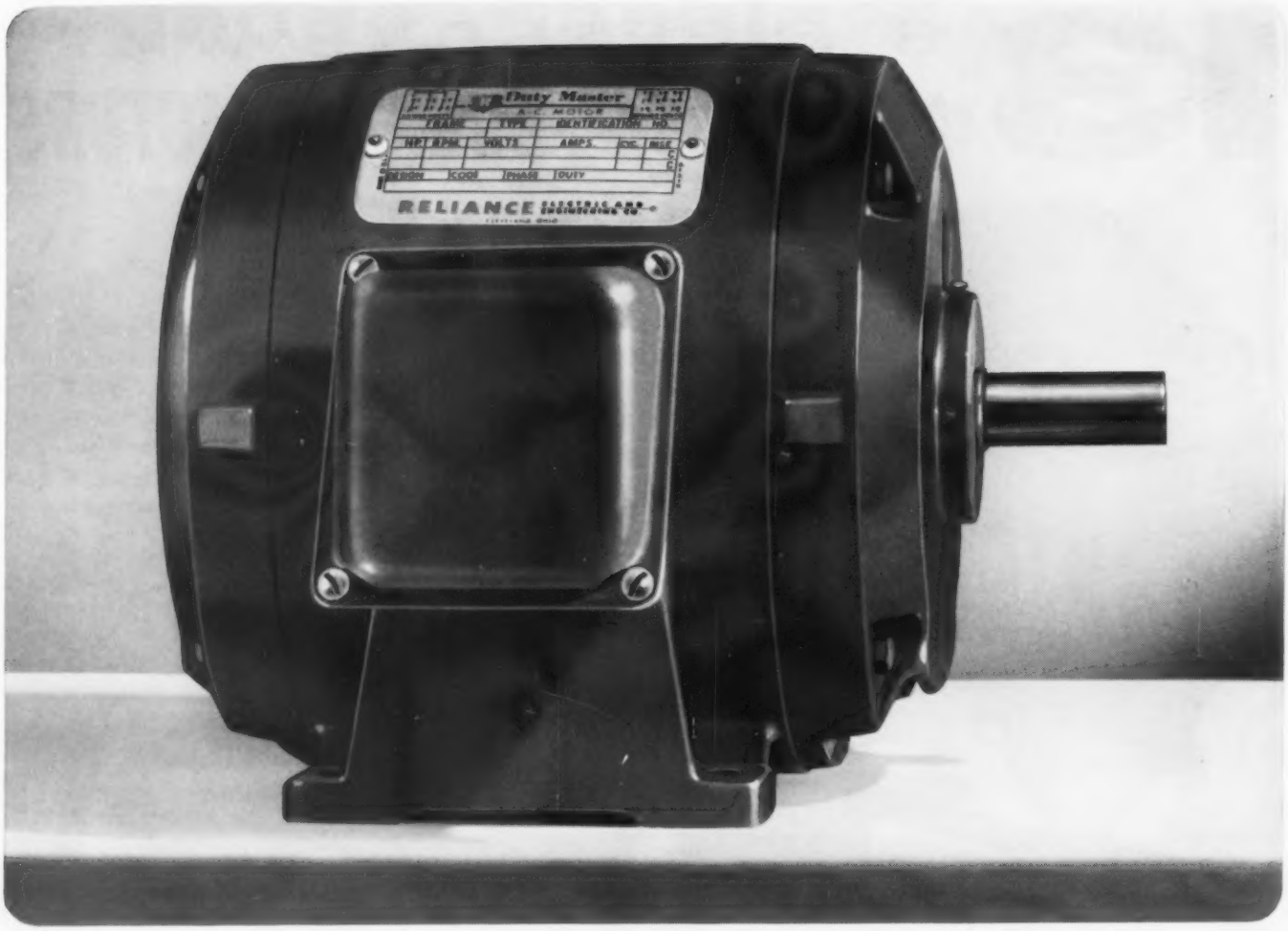

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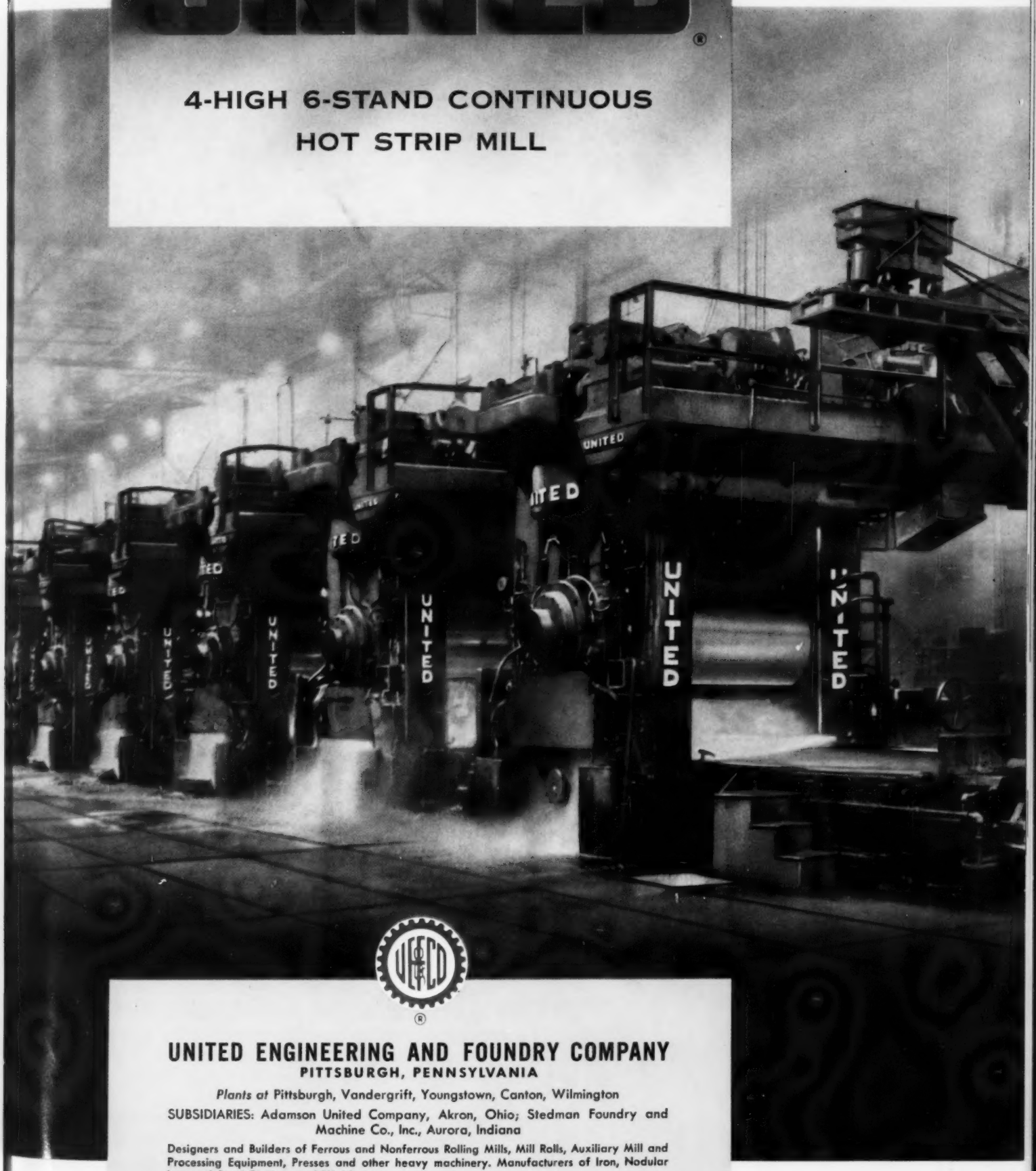

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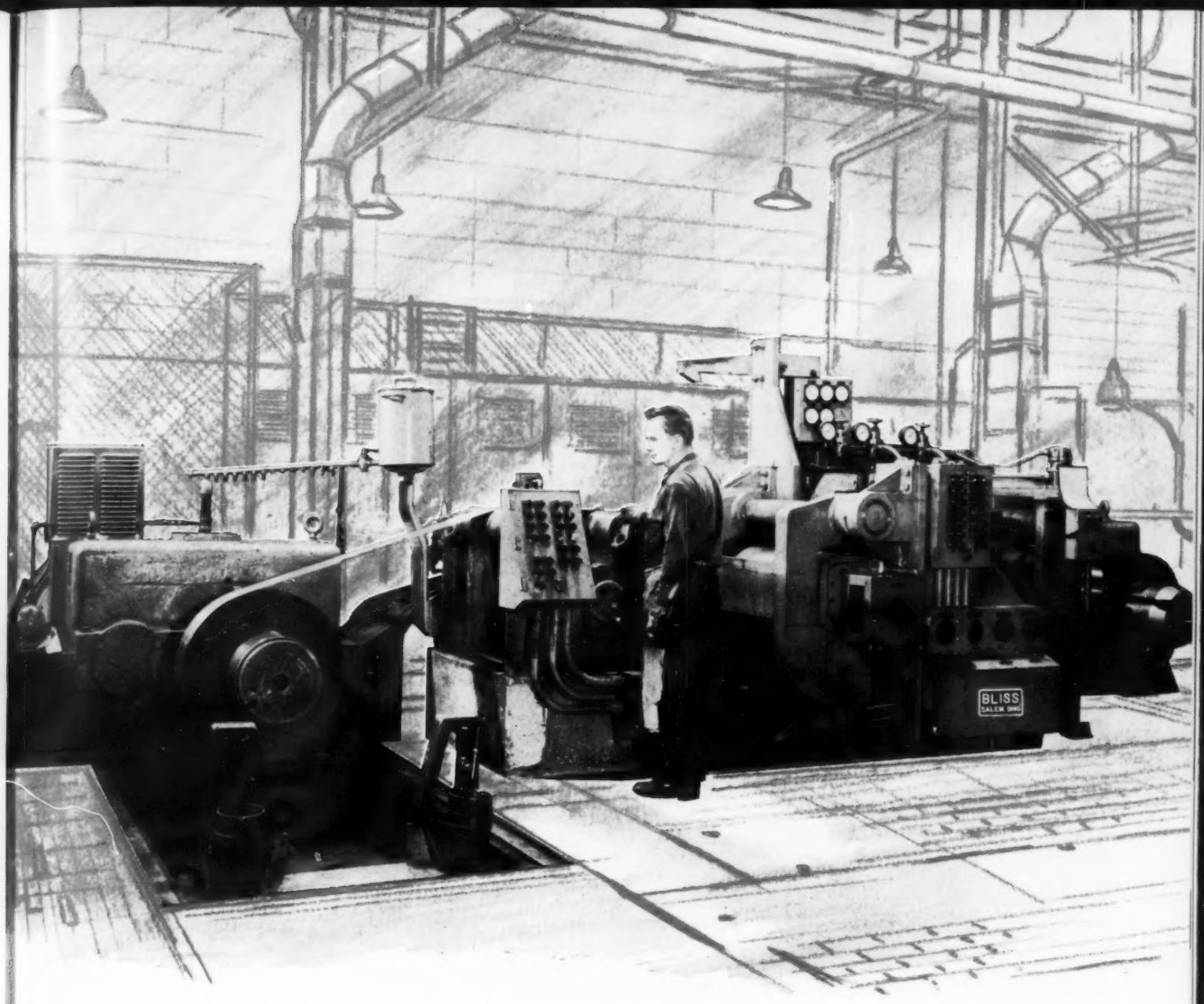

How Bliss helps ease the tension at Acme Steel

This new rewind line, designed and built by Bliss' Rolling Mill Division, helps Acme Steel's Riverdale, Ill., plant achieve a higher quality cold rolled strip.

All strip in widths from 2" to 26" and gages of .050" and thinner is run through the line before annealing. Between the line's mandrel-type payoff reel and the tension reel are a pinch roll and an electrically-controlled bridle which the operator sets for various strip widths and gages.

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This is THERMAL FATIGUE

This photograph shows a heat-resistant alloy casting after thermal-fatigue failure.

Thermal fatigue begins with cyclical heating and cooling which produces alternate expansion and contraction. The shape of the casting hinders this expansion and contraction. As a result, hindered expansion and contraction stresses develop and increase until plastic flow occurs. This plastic flow produces a network of thermal-fatigue cracks and this cracking leads to failure.

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patent reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C. at 25 cents . . . patents reviewed cover period August 18, 1959 through September 15, 1959.

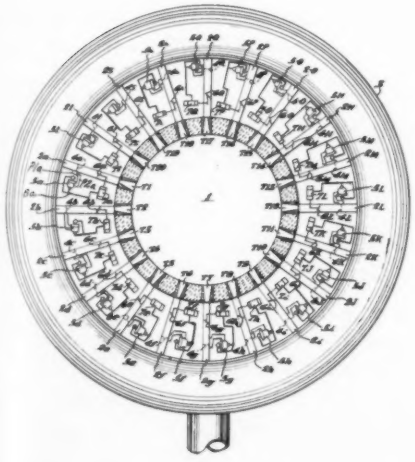
CONTROLLING THE BLAST TO THE TUYERES OF BLAST FURNACES

△ U. S. 2,904,327, issued Sept. 15, 1959, to Mitchell J. Boho, assigned to Hagan Chemicals and Controls, describes an apparatus for effecting substantially equal volumetric flow of the available supply of wind or hot blast to the tuyeres of a blast furnace.

In accordance with the present invention, the volumetric flow through each tuyere pipe is measured across an orifice. A damper or valve is provided in each tuyere pipe for adjusting the flow through it. Because the resistance to flow into the charge at the various tuyeres may differ from tuyere to tuyere, the distribution of wind or hot blast among the tuyeres is based on the fact that the regulating valve or plug in one of the tuyere pipes should be held in open or nearly fully open position. Thus in accordance with the present invention, the valve or plug in one of the pipes will be set in substantially wide open position to allow the flow to assume whatever value it will take, while the plugs or valves in the other tuyere pipes are so modulated that the volumetric flow in all of the tuyere pipes will be substantially equal. As the supply to blast to the bustle pipe changes, such flow adjustments are made in all the tuyere pipes that each gets its proportionate share of the total.

As indicated in Figure 1, the respective tuyere pipes are provided with orifices 4a to 4t. The flows in the respective tuyere pipes are measured by loaded, flow measuring and regulating devices 5a to 5t. The tuyere pipes are also provided with plug valves shown diagrammatically as dampers 6a to 6t, respectively, and the respective dampers are operated by power cylinders or operators 7a to 7t, respectively. Each power cylinder is controlled by its associated regulator.

Figure 1



BLAST FURNACE CHARGING SYSTEMS

△ U. S. 2,902,179, issued Sept. 1, 1959, to Erik T. A. Tesch and Isak E. Johansson, assigned to T. An. Tesch Aktiebolag, provides a completely automatic charging system for a blast furnace, in accordance with a predetermined charging sequence or program.

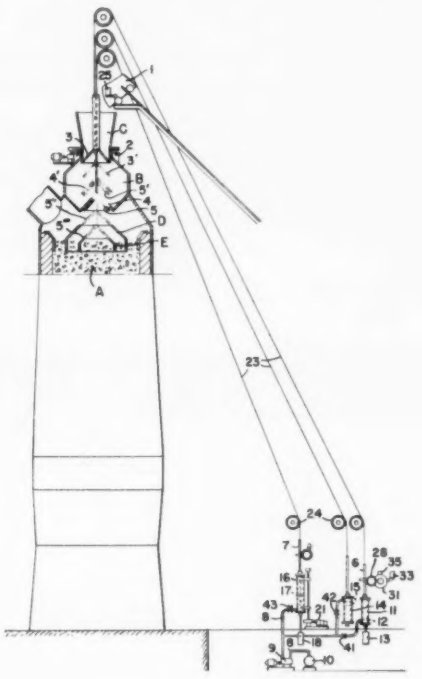


Figure 2

As shown in Figure 2, the lifting and lowering movements of the bells are performed by means of fluid pressure cylinders containing pistons and communicating through pipes 8 having shutoff valves with the pressure fluid pump 9 and the collecting tank 10.

The bell 3 is operated by the fluid pressure cylinder 11 and piston

12. A counterweight 13 serves to balance the weight of the bell 3 in such a manner that the lifting movement of the bell takes place without the use of fluid pressure.

The bell 4 is operated by a fluid pressure cylinder 14 and piston 15.

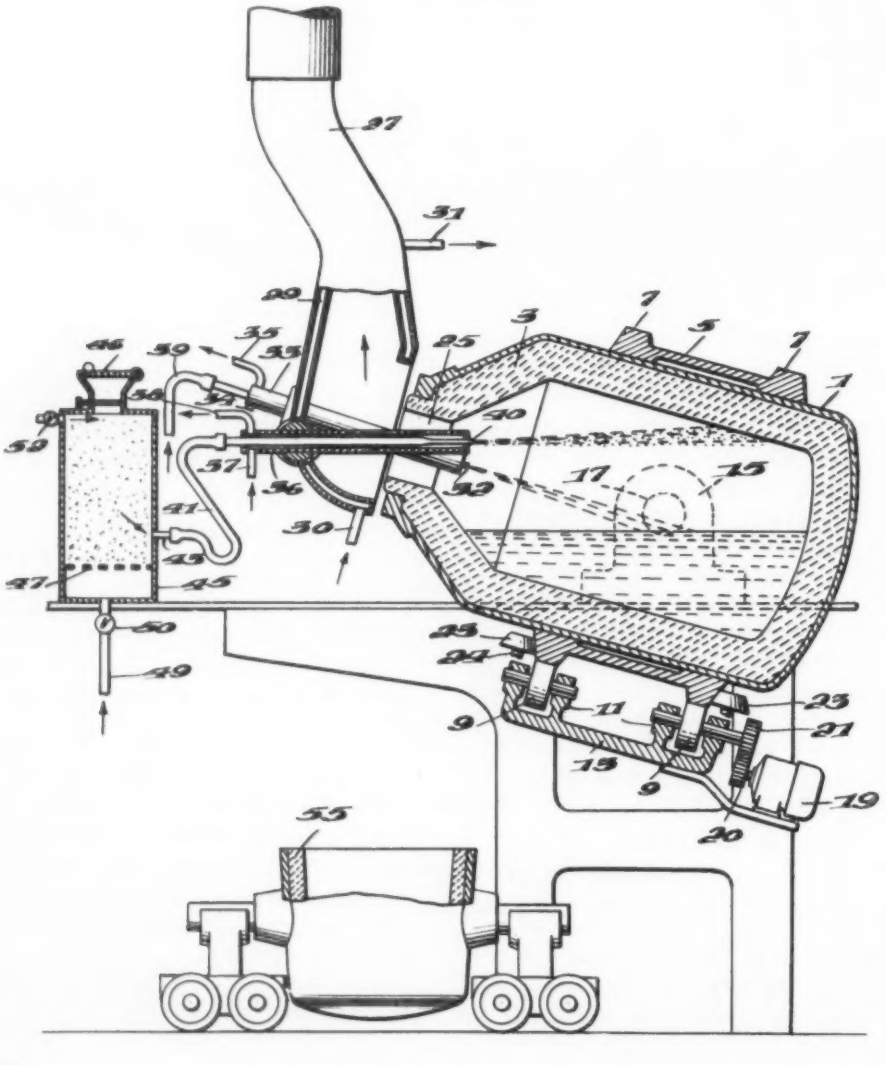
The bell 5 is operated by the fluid pressure cylinder 16 and piston 17 which serve to lower the bell 5 into the positions 5′ and 5″ and also by an electrical aggregate 21 serving to lower and lift the bell between the positions 5 and 5″ in that the electrical machinery lifts and lowers the fluid pressure cylinder 16. The counterweight 18 serves to effect the upward movement of the bell 5 from the position 5″ to the position 5′.

The transmission of power between the fluid pressure cylinders and the bells is effected by means of cables 23 and sheaves 24.

Each time that the upper hopper C receives a carload, the upper bell 3 is opened so that this load is dumped into the lower hopper. The control means may be so constructed and adjusted, e.g., in the case of charging a furnace where the material is to be introduced into the furnace alternatingly along the shaft wall, centrally and in an intermediate zone, that the lower hopper B, when the charge is to be placed along the wall, is emptied, e.g., after introducing four loads from the hopper C. The distributing bell 5 is then brought into the position 5″ so that the material flows along the outer stock distributor D. To introduce the material into the furnace A in a zone between the furnace wall and the central portion of the furnace, the control means are so adjusted that the bell 4 is opened after supplying three loads to the hopper B. The bell 5 is then lowered into the position 5″ so that the material passes through the annual passage between the stock distributors D and E.

When it is desired to introduce the charge centrally, the bell 4 of the lower hopper B is lifted after two loads have been dumped there into from the upper hopper C. The bell 5 is then lifted to the position 5′ so that the material falls from the hopper B through the central openings of the two charge distributors D and E.

Figure 3



OXYGEN REFINING IN A ROTARY FURNACE

△ U. S. 2,902,358, issued Sept. 1, 1959, to Bo M. S. Kalling and Folke K. E. Johansson, assigned to Stora Kopparbergs Bergslags Aktiebolag, describes a method of counteracting localized high temperature attack on the furnace lining when melting and refining molten metal by means of oxygen in a rotary furnace.

As shown in Figure 3, mounted in the hood are two copper tuyeres, one ordinary blast tuyere 33 and one tuyere 36 for cooling means. Both are watercooled as indicated by water inlets 34 and 37 and outlets 35 and 38, respectively. Gas rich in oxygen is supplied to the pipe 32 of tuyere 33 through the flexible hose 39. The tuyere 36 has an inner pipe 40 which is connected to a flexible pipe 41 secured in the outlet pipe 43 of a lime suspending apparatus 45. This apparatus consists of a container having at its top a lime feeding sluice 46 and at its bottom portion a grid 47 and below the grid a pressure gas inlet pipe 49 provided with a valve 50 for the supply of gas for fluidizing the lime supplied to the grid from said sluice. Another pressure gas inlet pipe 51, provided with a valve 52, opens into the container at a suitable level above the grid for supplying feeding gas, if required in addition to that supplied through pipe 49. The furnace can be tapped into a movable ladle 55. The necessary quantity of pressure gas should only amount to a few (less than 10) cubic meters per ton of introduced powder, so that the quantity of gas that leaves the furnace will be increased only a little as a result of the supply by pneumatic means. If it is desired to avoid the introduction of oxygen and nitrogen into the furnace room by this operation it is possible to use other gases than air, e.g., carbon dioxide.

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A-1285A

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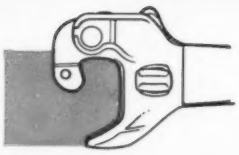
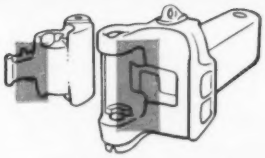
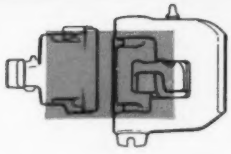


Gives longer service life. Liberal allowance for wear and distortion.

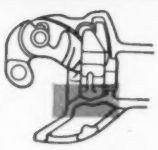


Has greater buffing strength. Substantial buffing shoulders in coupler head and knuckle.

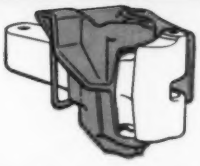


Has less pulling stress. Lugs reduce stresses on knuckle pin.

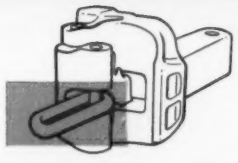
SHARON-10A • SHARON-10A • SHARON-10A



Features secure locking. V-shaped design stabilizes lock in coupler wall.



Is protected from molten metal. Hood protects uncoupling mechanism from metal splash.



Is versatile. Can be supplied with slotted or off-set knuckle for use with present link and pin equipment.

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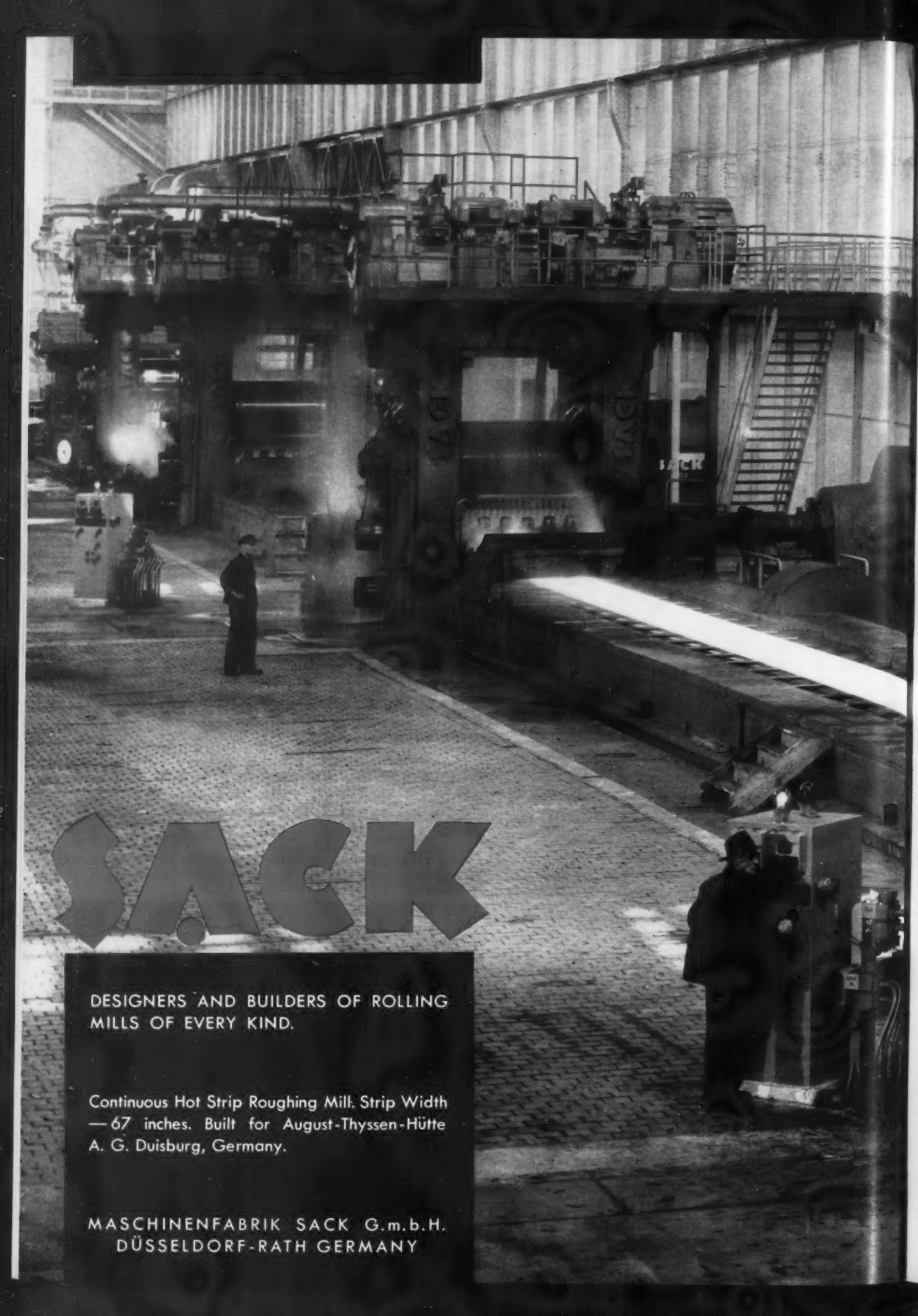

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Continuous Hot Strip Roughing Mill. Strip Width — 67 inches. Built for August-Thyssen-Hütte A. G. Duisburg, Germany.

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DÜSSELDORF-RATH GERMANY

DEVICE FOR INDICATING POURING HEIGHT OF A STEEL INGOT

△ U. S. 2,902,766, issued Sept. 8, 1959, to John A. Lindstrom and assigned to Jones & Laughlin Steel Corp., describes an apparatus for positioning a marker in an ingot mold to indicate the height to which the ingot should be poured. More particularly, it is concerned with such apparatus capable of positioning the marker at a predetermined distance above the stool on which the ingot mold rests.

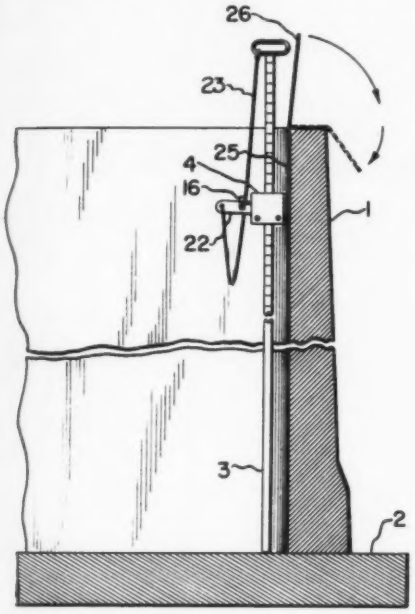


Figure 4

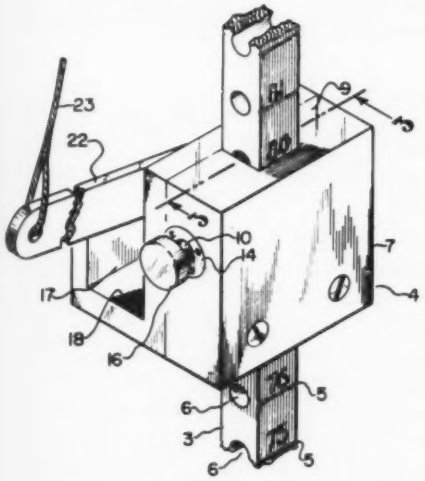
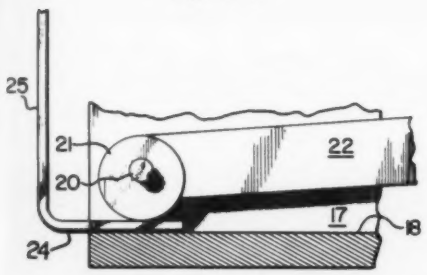


Figure 5

Figure 6



In Figures 4, 5 and 6 handle 22 of eccentric 21 is raised so as to increase the clearance between eccentric 21 and the bottom face 18 of channel 17. One end 24 of a hanger strip 25 is inserted between bottom face 18 of channel 17 and eccentric 21 and handle 22 moved toward bottom face 18 until strip end 24 is clamped between eccentric 21 and bottom face 18. The remainder of hanger strip 25 is then bent at approximately right angles so that it extends upwardly from the plane of channel bottom face 18. Cursor 4 is moved along rod 3 until it reaches a distance from the lower end of rod 3 corresponding to the height of mold desired as shown by the marked graduation 5 on bar 3 alined with top 9 of block 7. Cursor 4 is locked on bar 3 in that position by alining pin 10 with the corresponding hole 6 in bar 3. When alinement is reached, a spring forces the inner end of pin 10 into hole 6. The apparatus is now lowered by hand into the interior of an ingot mold 1 positioned on a stool 2 until the lower end of bar 3 rests upon stool 2. The apparatus is positioned adjacent one side of mold 1 so that the upright portion 25 of the hanger strip is flat against that side of mold 1. The end 26 of the hanger strip extending above the top of mold 1 is then bent over the mold top and downwardly on the outside an amount sufficient to insure the maintenance of the hanger strip 25 on the mold 1 when the apparatus of the invention is removed. Handle 22 is then raised so as to increase the clearance between cam 21 and bottom face 18 of channel 17 and the device is moved away from the mold wall until the lower end 24 of the hanger strip is cleared. The apparatus is then removed from the mold leaving the hanger strip in place with its lower end 24 extending at right angles from the mold wall to serve as an ingot height marker for the steel pourer.

SECTIONAL HOT TOP

△ U. S. 2,900,685, issued Aug. 25, 1959, to Edgar Marburg, assigned to United States Steel Corp., provides sectional hot tops which may be used either with big-end-down or big-end-up molds.

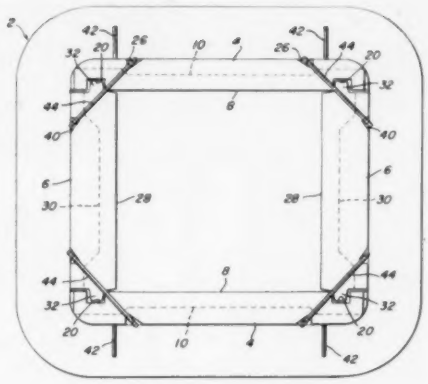


Figure 7

Figure 7 is a plan view of such a sectional hot top assembled on an ingot mold.

SURFACE BLOWING PROCESS FOR MAKING STEEL

△ U. S. 2,900,249, issued Aug. 18, 1959, to Walter L. Kerlie, assigned to United States Steel Corp., describes a process for refining pig iron by surface blowing. Among other features, the process of this invention reduces iron losses and increases the life of the converter refractory lining by controlling the circulating movement of the slag over the molten metal and by

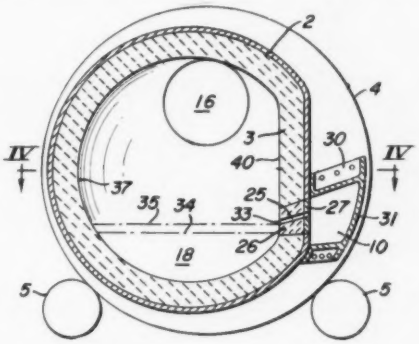


Figure 8

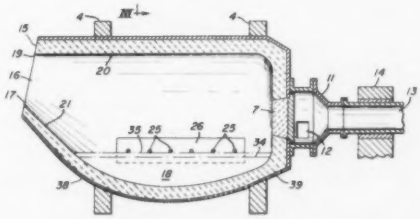
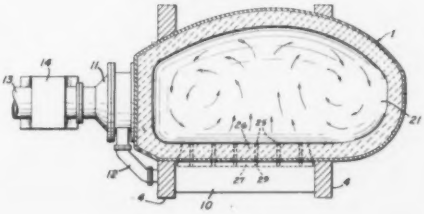


Figure 9

Figure 10



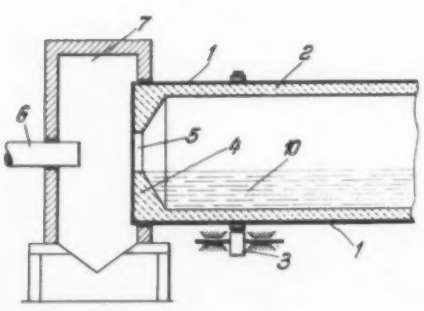
causing the gases to flow spirally through the converter.

As shown in Figures 8, 9 and 10, the main body of the vessel has a curved or barrel shape and has its ends rounded in the regions 38 and 39. In addition, the side wall of the vessel is flattened in the region 40 above the tuyere block 26 so that the bath contained in the vessel will have a substantially D-shaped surface contour with the tuyeres 25 arranged along the flat side of the D-shape. In operation the air blast from the tuyeres 25 moves the slag across the surface of the metal toward the opposite wall 37. However, and by reason of the curvature of the wall 37 in a horizontal plane, the slag will not build up against such wall but will circulate continuously in two distinct zones, one at each end of the vessel, over the surface of the metal as indicated by the arrows in Figure 10. This circulating movement of the slag gives rise to more intimate mixing with the metal as well as a more rapid fluxing of the slag forming materials because the FeO formed by the action of the blast on the metal is immediately swept into the slag by the spiralling movement of the waste gases. The rapid fluxing of the slag and the intimate mixing of slag and metal results in a fast oxidation rate and develops a homogeneous slag at an early stage in the blow. Consequently the end point of the heat is reached quickly and without any uncertainty.

DIRECT SMELTING IN ROTARY KILNS

△ U. S. 2,900,248, issued Aug. 18, 1959, to Friedreich Johannsen and assigned to Aktiengesellschaft fur Unternehmungen der Eisen-und Stahlindustrie, describes a process for the production of iron by direct smelting in a rotary kiln.

Figure 11



OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or assignee
2,899,747	8/18/59	Method of measuring the bearing length of drawing dies	United States Steel Corp.
2,899,843	8/18/59	Drive mechanism for flying shears	Einar W. Nilsson
2,900,143	8/18/59	Brake control for uncoiler	The McKay Machine Co.
2,900,246	8/18/59	Reduction of iron oxide with hydrogen	Hydrocarbon Research, Inc.
2,900,247	8/18/59	Method of making sponge iron	Fierro Esponja Sa
2,900,250	8/18/59	Free-machining austenitic alloys	Universal Cyclops Steel Corp.
2,900,285	8/18/59	Cleaning the air chambers of an open hearth furnace	Mannesmann A. G.
2,900,852	8/25/59	Rolling mill conveyor control system	Western Electric Co. Inc.
2,901,132	8/25/59	Blast furnace seal	Interlake Iron Corp.
2,901,236	8/25/59	Sintering apparatus	Sayre & Fisher Co.
2,901,346	8/25/59	Mild steel	Consett Iron Co. Ltd. et al.
2,901,384 & 2,901,386	8/25/59	Heat treatment of cast iron	Regie Nationale des Usines Renault
2,901,818	9/1/59	Stripping a rolled tube blank from a mandrel bar	United States Steel Corp.
2,901,828	9/1/59	Apparatus for indicating the dip of an electrode in a submerged electric arc furnace	Vanadium Corp. of America
2,901,990	9/1/59	Basic roof for open hearth furnaces	General Refractories Co.
2,902,143	9/1/59	Unloading mechanism for belt conveyors	United States Steel Corp.
2,902,359	9/1/59	Recovery of cobalt and nickel from mill scale, etc.	Crucible Steel Co. of America
2,903,386	9/8/59	Heat-hardened stainless steel	Armco Steel Corp.
2,903,494	9/8/59	Electrode attaching device for electric arc furnaces	Demag-Elektrometallurgie G.m.b.h.
2,903,925	9/15/59	Rolling mill with segmental rolls	W. H. A. Robertson & Co. Ltd.
2,903,926	9/15/59	Controlling the contour of rolls in a rolling mill	Baldwin-Lima-Hamilton Corp.

In Figure 11, numeral 1 designates a sheet metal hull of the rotary kiln cylinder which is lined with a fireproof ceramic layer 2 on the inside.

The kiln is supported on rollers 3. The kiln is set in rotation by the conventional power drive (not shown). It possesses a charging or upper end and a discharge or lower end, both ends being enclosed by chambers in kiln heads built from fireproof masonry.

In the end wall at the discharge end of the kiln, there is provided a central aperture 5 surrounded by the end wall portion forming a baffle ring 4 for damming up the charge 10 in the nodulizing zone of the kiln adjacent the discharge end.

Into the chamber 7 of the discharge head there protrudes a burner pipe 6 which serves for heating the kiln by means of gaseous, liquid or fine-grained pulverulent fuels.

Air is injected into the kiln through this same burner pipe 6 which ends in a nozzle at a short distance from aperture 5 in the baffle ring 4.

Air is injected through pipe 6 at a velocity of 10 to 30 meters per second in order to obtain solid nodules of low carbon content.

The air which is injected with a velocity higher than the velocity prevailing in the kiln itself is more turbulently agitated in the lower and central portion of the kiln than the air drawn in by kiln suction, and causes a substantially more rapid and intense combustion of the reduction gases developed therein. An increased temperature in the discharge zone of the kiln and a quicker and more complete reduction of the oxides in the central region of the kiln, are the result. Therefore, the amount of auxiliary heating by means of burners conventionally provided at the discharge end of the kiln, may be considerably restricted. At the same time, the fuel admixed to the charge is better exploited, in consequence whereof the quantity of solid fuel of 30 to 40 per cent usually required for the reduction of ores in a rotary kiln, can be reduced to 22 to 30 per cent by weight of the total charge.

The intensive combustion at the discharge end of the kiln and the increased temperature generated in this kiln zone, also decreases the viscosity of the slag, and consequently favors the formation of larger nodules, even at the higher throughput rate of the kiln.

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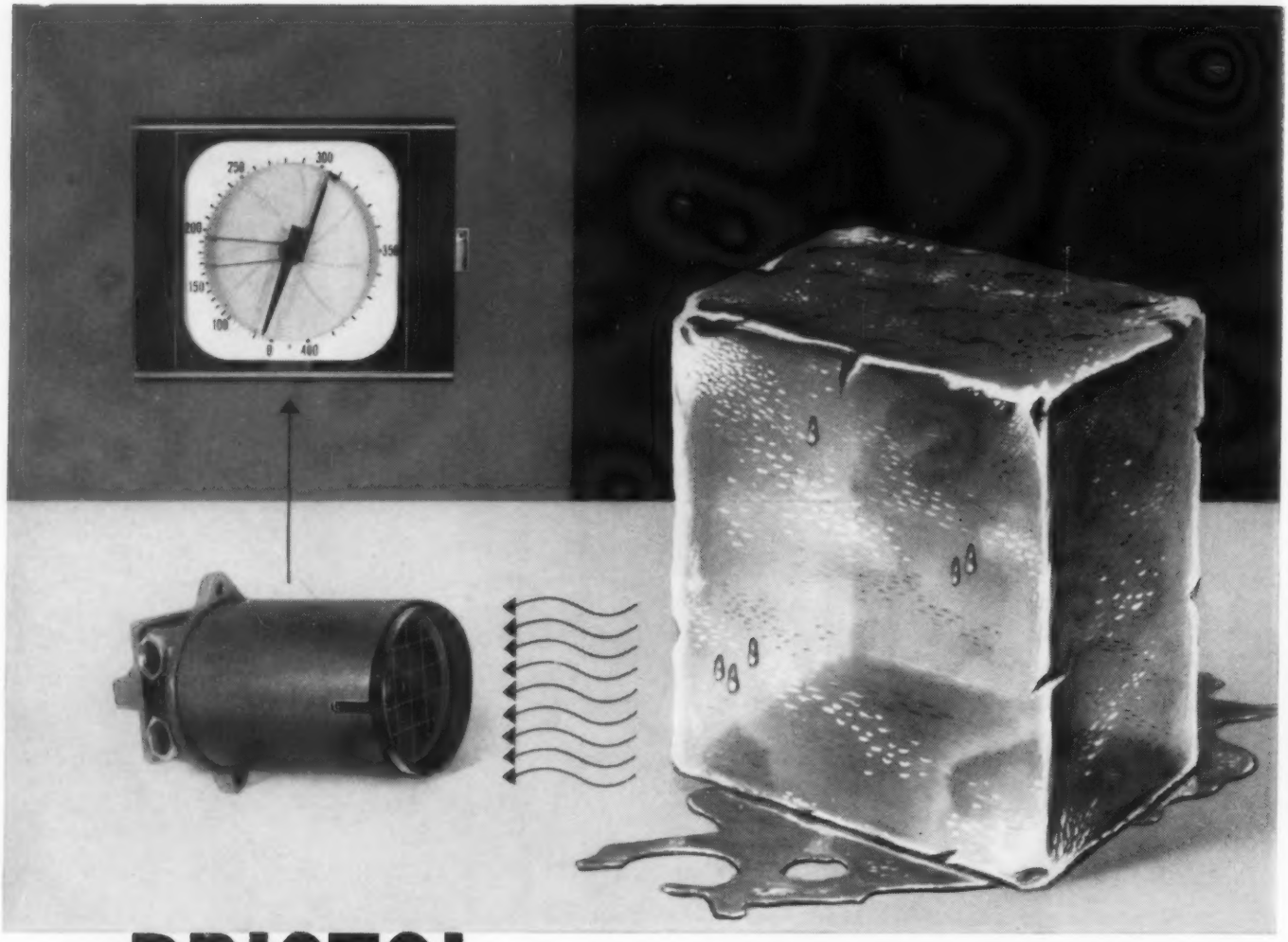

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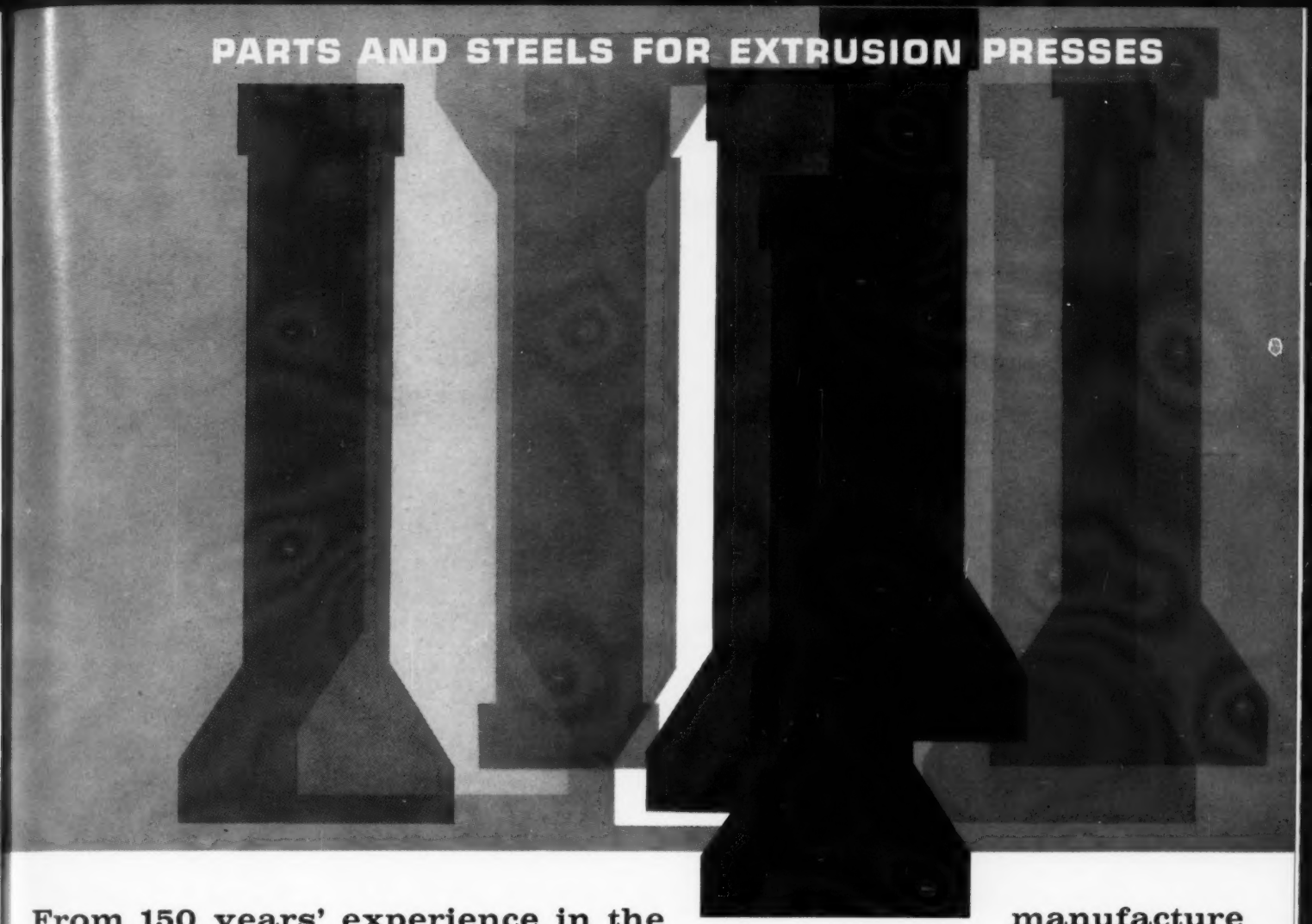

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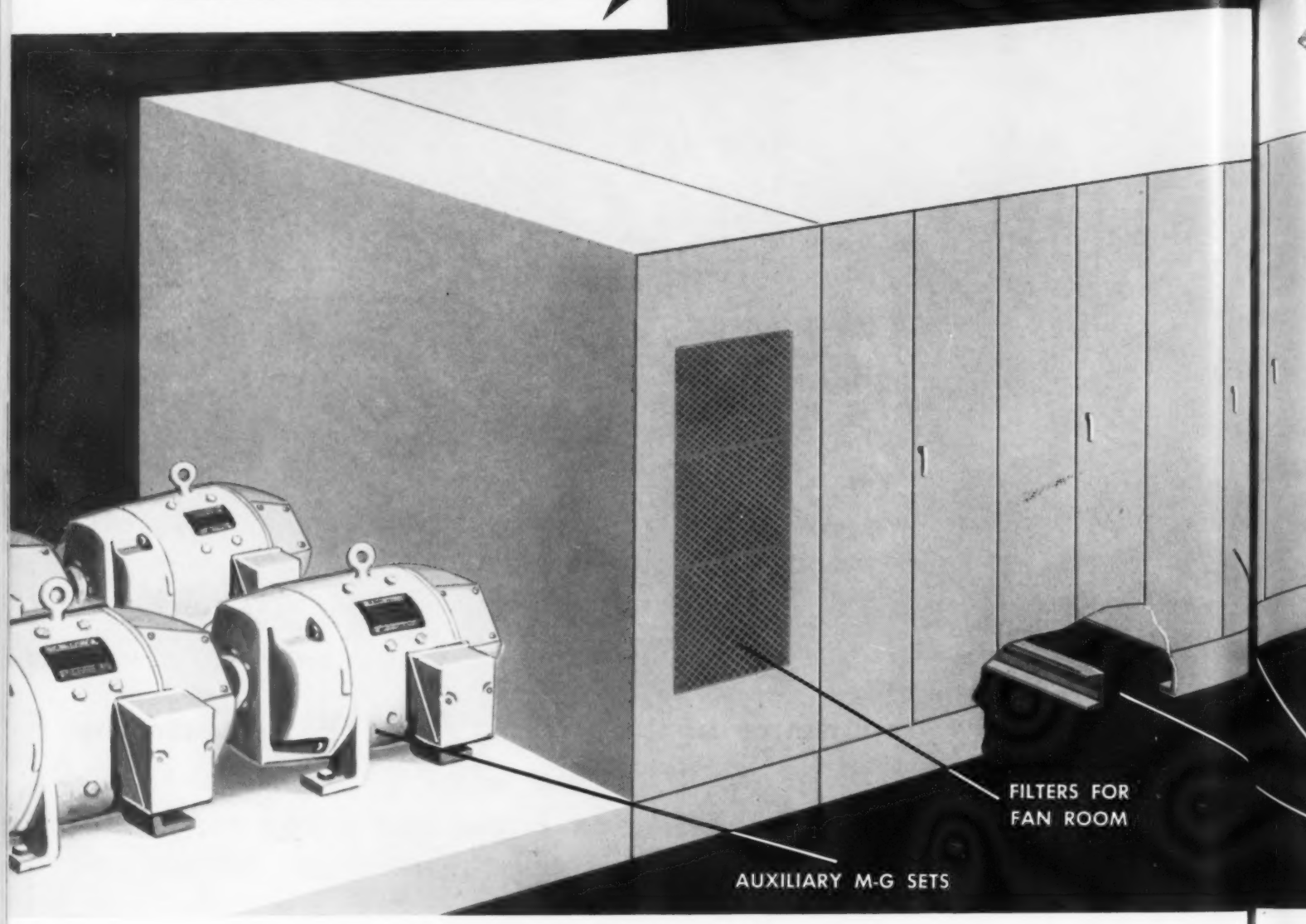

A NEW PRACTICE IN PROCESS-LINE CONTROL

G-E "packaged" motor-control rooms reduce

The latest innovation in modern steel-mill process-line control is General Electric's new "packaged" motor-and-control room. This novel design, developed jointly by General Electric and Jones and Laughlin Steel Corp., groups all controls and m-g sets into one compact centralized unit. The above unit will be installed at J&L's Aliquippa, Pa., works, as part of their continuing facilities-improvement program. Previously, the installation expense on this equipment often matched or exceeded the actual cost of the equipment. The new G-E motor-control room design cuts installation costs as much as 40 percent!

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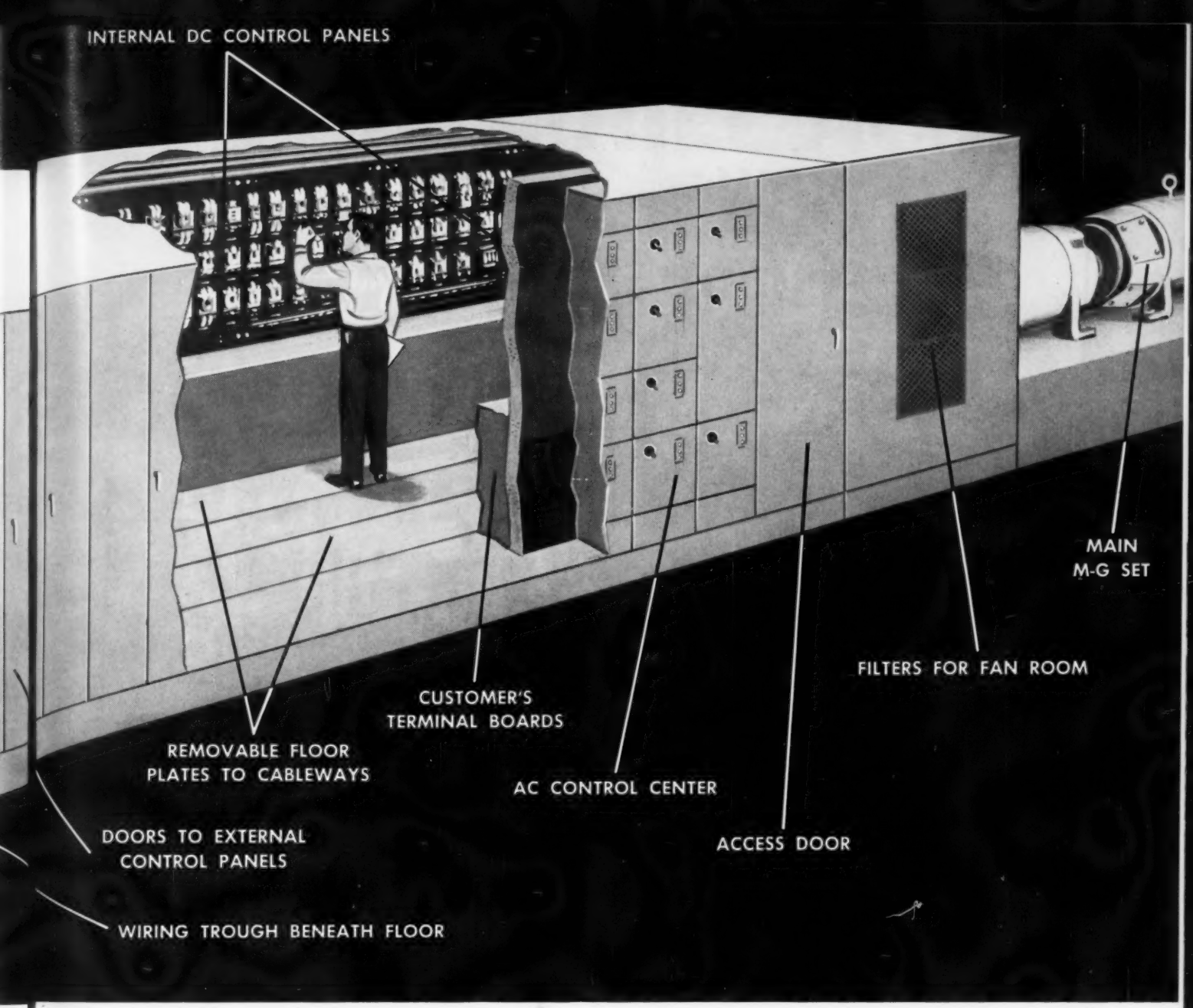
Independent control unit—The General Electric motor-control room is a completely co-ordinated, pre-assembled unit in itself, and in many cases, eliminates the need for a separate motor room. Since the motor-control room is self-contained, it may be located either near the driven equipment or in some previously unused area of the mill.

Field wiring is reduced by one-third or more—All internal connections are made and tested before the motor-control rooms are shipped. The only field wiring required is the connection of the power source and the leads to the operators' stations and the drive motors.

Construction engineering costs reduced—General Electric's grouped control concept enables the mill to know its conduit requirements much sooner. Thus, fewer,



installation costs as much as 40 percent!

less-complex construction diagrams are needed, and actual construction can begin at an earlier date.

Common base minimizes installation time—This new "packaged" motor-control room, delivered on its own self-supporting platform, can be immediately set on a normal mill floor. It does not require expensive, specially-constructed foundations. With m-g sets built and shipped on a common base, the need to align them at the mill site is eliminated. In addition, regulating equipment is factory-tested prior to shipment, further expediting startup time.

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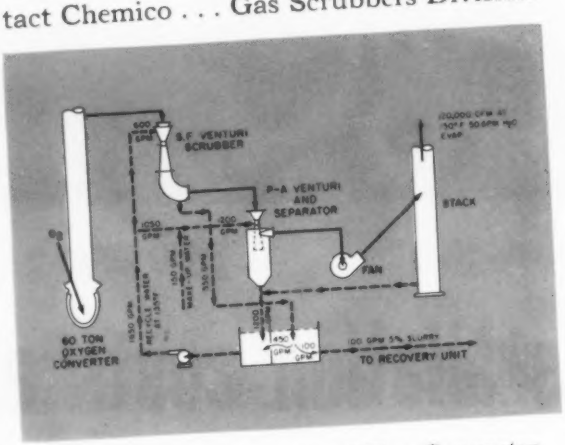

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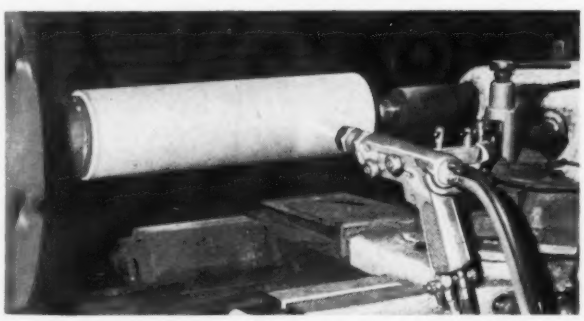

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STOPS RUST AND PROVIDES LASTING BEAUTY

Gone are the days when color was used for the sake of color alone. Today, color is functional—helping to improve morale and increase efficiency—serving to color-code and mark safety areas, etc. The Rust-Oleum New Color Horizons System goes even further. It combines four important factors (1) the ability to stop rust, (2) smart, modern color harmony, (3) the durability to last and last, (4) ease of application that saves time, money, and metal. See how this system can bring lasting beauty to your plant, machinery, equipment, tanks, fences, etc. Your Rust-Oleum Industrial Distributor, with your Rust-Oleum Factory Specialist, will be happy to survey your plant and provide complete recommendations. Prompt delivery is assured from Industrial Distributor stocks in all principal cities of the U.S., Canada, and many countries around the world.

Faced with coating problems like these? Heat resistance, water resistance, chemical resistance, floors, galvanized metal, coatings that will dry in less than thirty minutes? Rust-Oleum, in its various systems, can be your answer. Call your Rust-Oleum Industrial Distributor, or write for the facts.

Apply Rust-Oleum 769 Damp-Proof Red Primer directly over sound, rusted surfaces to STOP RUST and cut maintenance costs

Just scrape and wirebrush to remove rust scale and loose rust—then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust. Its **specially-processed** fish oil vehicle penetrates rust to bare metal as proved in radioactive tracing studies. You save time and money, as costly surface preparations are usually reduced.

RUST-OLEUM®

See our catalog in Sweet's.

STOPS RUST!®

Distinctive as your own fingerprint.
There are imitations,
but only **one** Rust-Oleum.
Accept no substitute.

PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY-FIVE YEARS

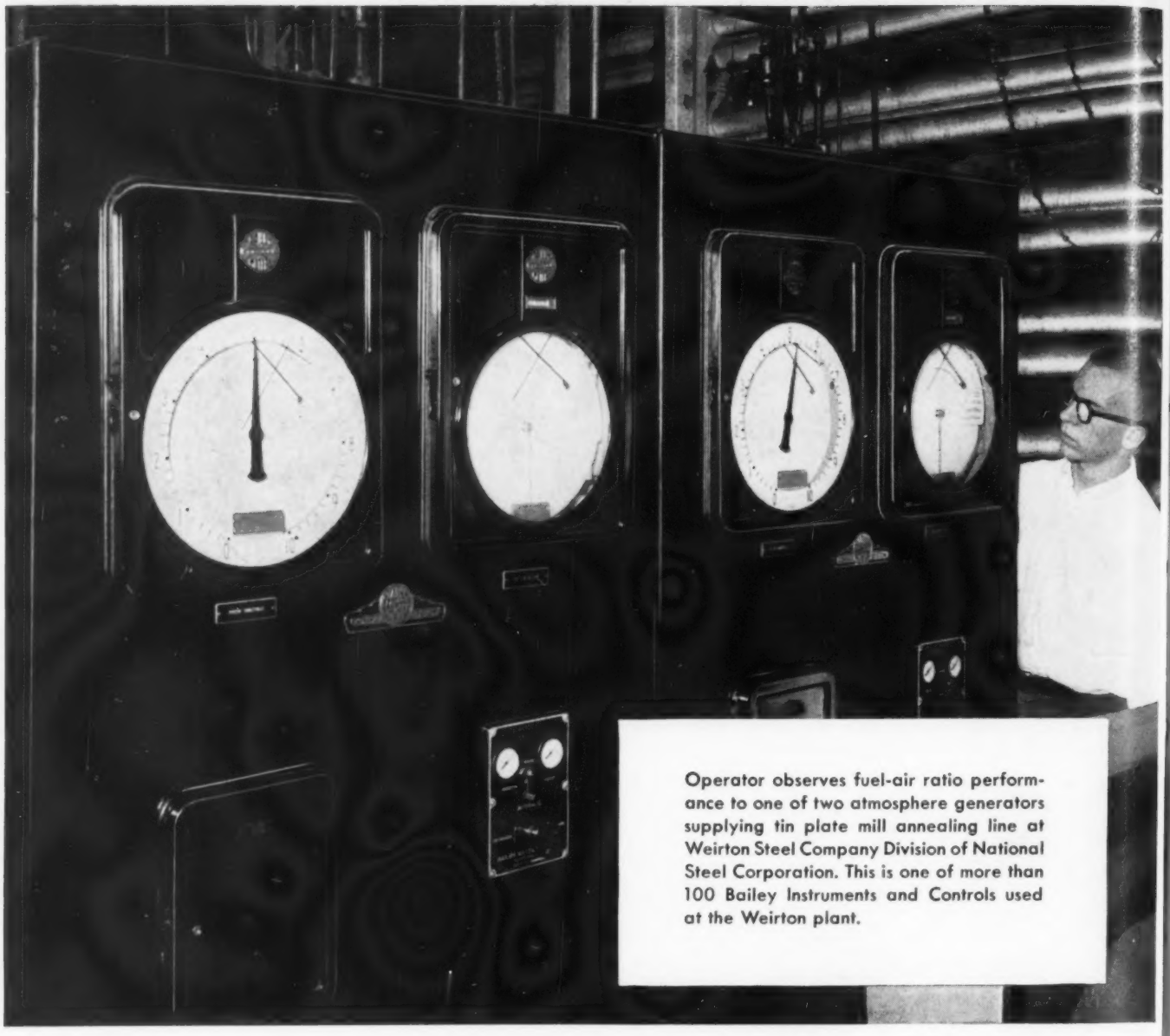
You take the brush! Try a free test sample!

ATTACH TO YOUR LETTERHEAD

RUST-OLEUM CORPORATION
2984 Oakton Street • Evanston, Illinois

At no cost or obligation, please send me:

- ☐ New full-color catalog on New Color Horizons System and specialized Rust-Oleum systems. Including color charts and applications.
- ☐ FREE TEST SAMPLE of Rust-Oleum 769 Damp-Proof Red Primer.
- ☐ Please have your representative contact us to discuss a plant survey.



Operator observes fuel-air ratio performance to one of two atmosphere generators supplying tin plate mill annealing line at Weirton Steel Company Division of National Steel Corporation. This is one of more than 100 Bailey Instruments and Controls used at the Weirton plant.

Bailey Atmosphere Generator Control automatically regulates total combustibles for tin plate annealing

Bailey's Atmosphere Generator Control is a completely packaged automatic control system which measures *total combustibles* in annealing.

Manual settings are made only during start-up or shutdown. Fuel-air ratio to generators is adjusted by the control system to maintain constant total combustibles despite variation in fuel quality. Response to atmosphere changes is fast, and total combustibles are accurately measured, since the Bailey Analyzer is not subject to errors due to variability of other atmosphere constituents. The Analyzer is sensitive to changes of less than ±0.02% total combustibles.

The performance of this instrument is assurance of final product quality. See your Bailey Engineer, or write the Iron and Steel Division for more information.

S112-1

IRON AND STEEL DIVISION

BAILEY METER COMPANY

1047 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

WHY KEEP THE UPKEEP?

MAINTENANCE COSTS		TIME OUT
January	VERY HIGH	22 hours
February	STILL HIGH	17 hours

Switch to the

HKP® PORTER *Hydraulic* ONE-HOSE ROD and BAR CUTTER

IT'S PRACTICALLY . . .

MAINTENANCE FREE!

To slash those sky-high costs on bar and rod cutting operations and maintenance in your mill you need the superbly efficient, rugged, trouble-free one-hose PORTER HYDRAULIC ROD and BAR CUTTER. An all-job team of 3 Cutterheads and 5 Power Unit sizes offers just the right combination to handle any of your cutting work — faster better and at far lower cost. Here's why:

CONTINUOUS TROUBLE-FREE OPERATION

CUTTERHEAD PROTECTION — that eliminates constant "TIME OUT" and HIGH MAINTENANCE COSTS!

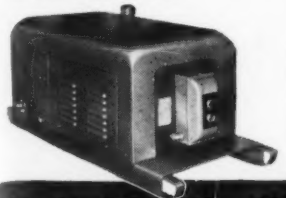
- **LONGER BLADES** with more bearing surface and rigid alignment eliminate side thrust and blade breakage.
- **FILTERED AIR** taken into the cylinder is forced out around the movable blade on each cut — eliminates the danger of dirt reaching bearing surface causing oil leakage and wear.
- **CONCENTRIC DESIGN** eliminates excessive wear of cylinder wall and ram.
- **LARGER CYLINDER AREA** allows the tool to cut capacity stock at a lower operating pressure, resulting in longer life for seal and hose.
- **SAFE, 12 VOLT CONTROL SWITCH** at the cutterhead gives instant finger-tip performance.
- **"KEY-POINT"** wear and replacement reduced to the minimum because of these exclusive HKP features.

A TRUE HYDRAULIC SYSTEM with these efficient, maintenance-saving features:

- **CONTROL VALVE** big and accurate enough for all industrial work. Solenoid operated.
- **EASY TO CHANGE RESERVOIR TYPE 10-MICRON OIL FILTER.**
- **PLUS** many other exclusive HKP features.

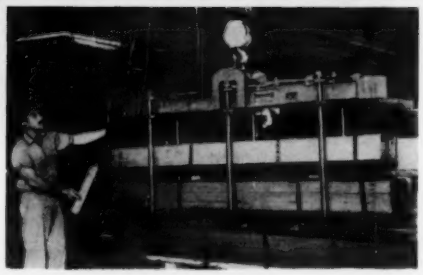
Ask to have a Porter Engineer tell you how the 3 CUTTERHEAD sizes and 5 HYDRAULIC POWER UNITS can provide the exact combination for your requirements.

OR — WRITE FOR COMPLETE PORTER HYDRAULIC ROD and BAR CUTTER FOLDER.



ATTENTION! Production and Quality Control Depts. Ask about our **NEW UPSET TESTING MACHINE!**

H. K. PORTER, INC. Somerville 43, Mass.



$25,000 AND 2,800 Square feet of "SPACE" SAVED with a MANSAVER® Sheet Grab

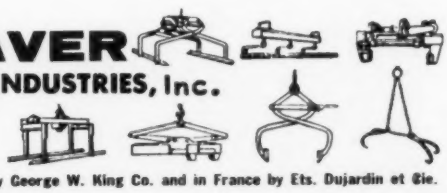
We can cite many cases where Mansaver Grabs have actually eliminated the need for new buildings by utilizing every inch of floor space.

One large business machine manufacturer states: "Existing floor space allocated to punch press flat stock storage amounts to 2,225 square feet. Without the Mansaver Grab, we would have needed double the floor space, or at least 2,300 to 2,800 *additional* square feet. The Mansaver we are using has meant a savings in operations area available for other purposes. Since the value of floor space in this part of the factory is about $10.00 per square foot, *dollar savings amount to approximately $25,000.00.*" The grab cost only $1,235.00.

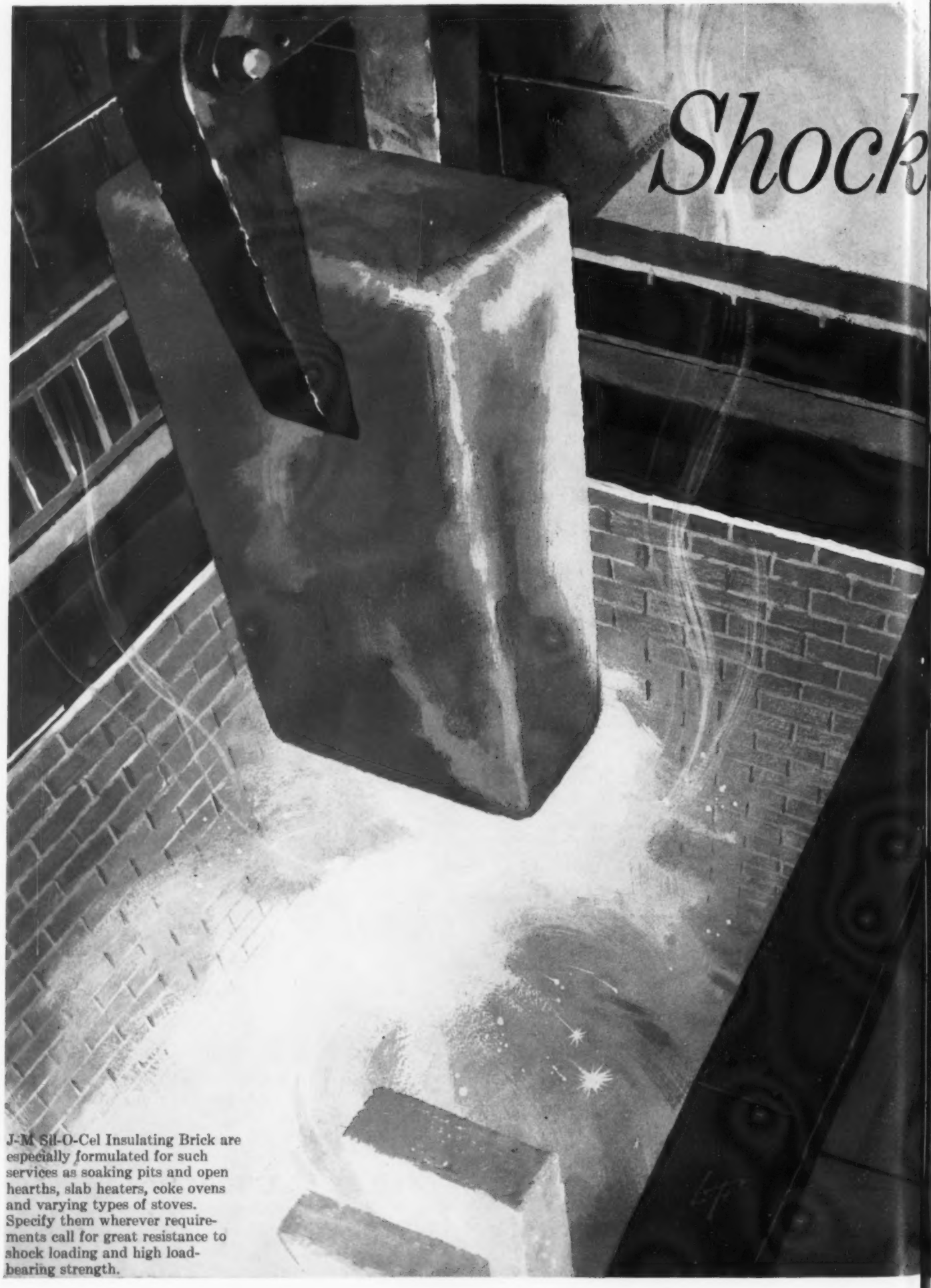
Whether *your* plant handles metal sheets, coils, palletized or skid-loads, bars, billets, rods, tubes, boxes, barrels, or other materials, Mansaver can supply a manual, semi-automatic, fully-automatic or power-operated Grab to do the same for you. Ask our District Representative into your plant to study your handling problem for presentation for our solution.

MANSAVER INDUSTRIES, Inc.

3116 East St., New Haven, Conn.



Also Manufactured in England by George W. King Co. and in France by Ets. Dujardin et Cie.



J-M Sil-O-Cel Insulating Brick are especially formulated for such services as soaking pits and open hearths, slab heaters, coke ovens and varying types of stoves. Specify them wherever requirements call for great resistance to shock loading and high load-bearing strength.

loads...and crushing weight

call for Johns-Manville Sil-O-Cel Insulating Brick!

Hot blast stove walls, open hearths, soaking pit bottoms—the unexcelled performance of J-M Sil-O-Cel® brick in rugged services like these explains their wide acceptance. Today, they are used as back-up insulation by virtually every major equipment builder.

Made of heat-resistant diatomaceous silica, Sil-O-Cel Insulating Brick are produced in three load-bearing types: Sil-O-Cel *Super* (to 2500F) and Sil-O-Cel *C-22* (to 2000F) for peak performance and long life under extremes of heat, weight and shock. Sil-O-Cel *16L* combines performance and economy for lower temperatures to 1600F.

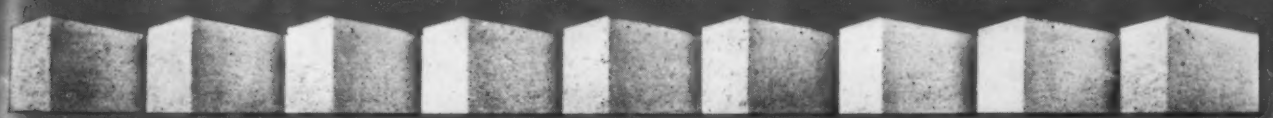
To bring you the right brick for your needs, Johns-Manville *also* offers six Insulating Fire Brick types. This wide selection of Insulating Fire Brick lets you choose the *one* brick that gives you the most favorable combination of temperature resistance, strength, conductivity, density and cost.

Write today for your copy of IN-115A, 8-page booklet on Johns-Manville Insulating Fire Brick. It gives complete physical and thermal properties of each type, along with sizes and shapes available. Address Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

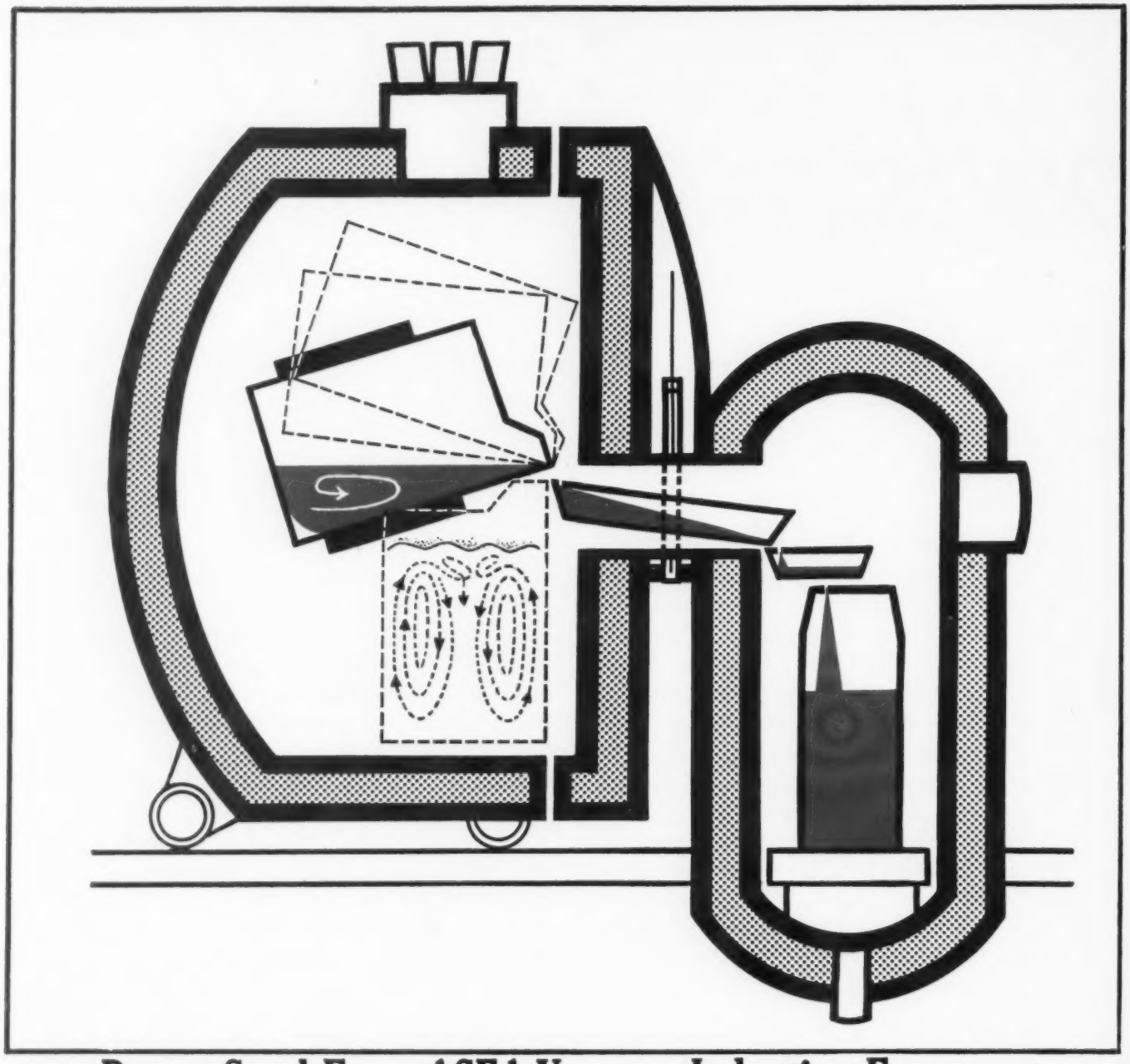
JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

THE INDUSTRY'S MOST COMPLETE LINE OF INSULATING FIRE BRICK



JM-3000	JM-28	JM-26	JM-23	JM-20	JM-1620	Sil-O-Cel® Super	Sil-O-Cel C-22	Sil-O-Cel 16L
service to 3000F	service to 2800F	service to 2600F	service to 2300F	service to 2000F	to 1600F exposed; to 2000F back-up	to 2500F back-up	to 2000F back-up	to 1600F exposed or back-up

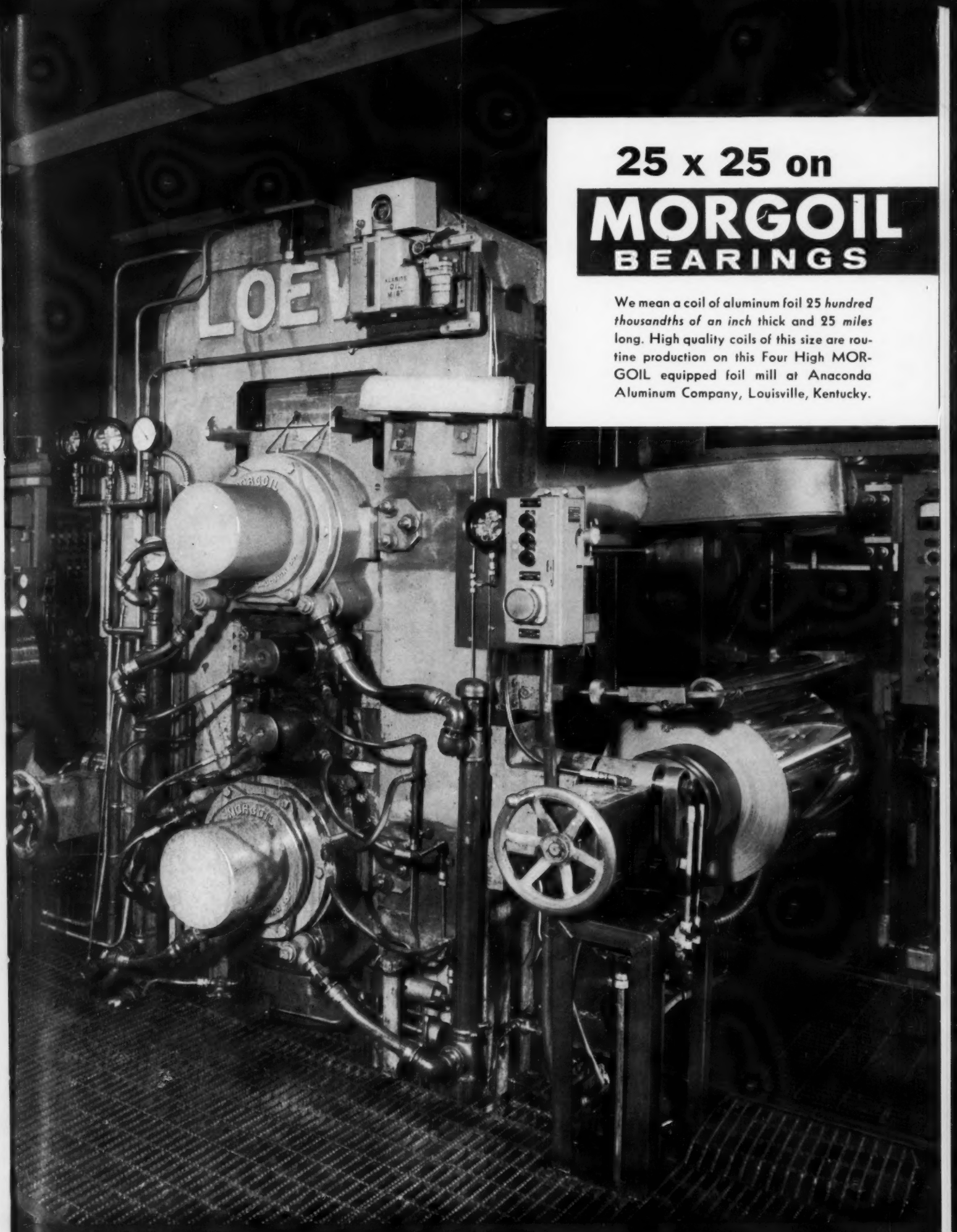


Better Steel From ASEA Vacuum Induction Furnaces

U.S. installation of 1100 kW, 5000 lbs. ASEA High Vacuum Furnace. Front View.

Induction melting in vacuum makes steel of high heat resistance, increased fatigue strength and higher yield points. In High Vacuum melting, only ASEA offers all the following advantages: ■ Accurate composition control of melt. ■ Poly-phase, low-frequency Induction Stirring increases homogeneity and purity of melt without temperature increase. ■ Accurate Temperature Control throughout process. ■ Reduced Degassing Time increases steel production. ASEA builds induction furnaces for vacuum melting up to 5,000 lbs. for air melting to 55,000 lbs. ASEA—one organization manufacturing and marketing all electrical and mechanical furnace equipment. Write for folder:

ASEA ELECTRIC INC.
500 Fifth Ave., New York 36, N. Y.

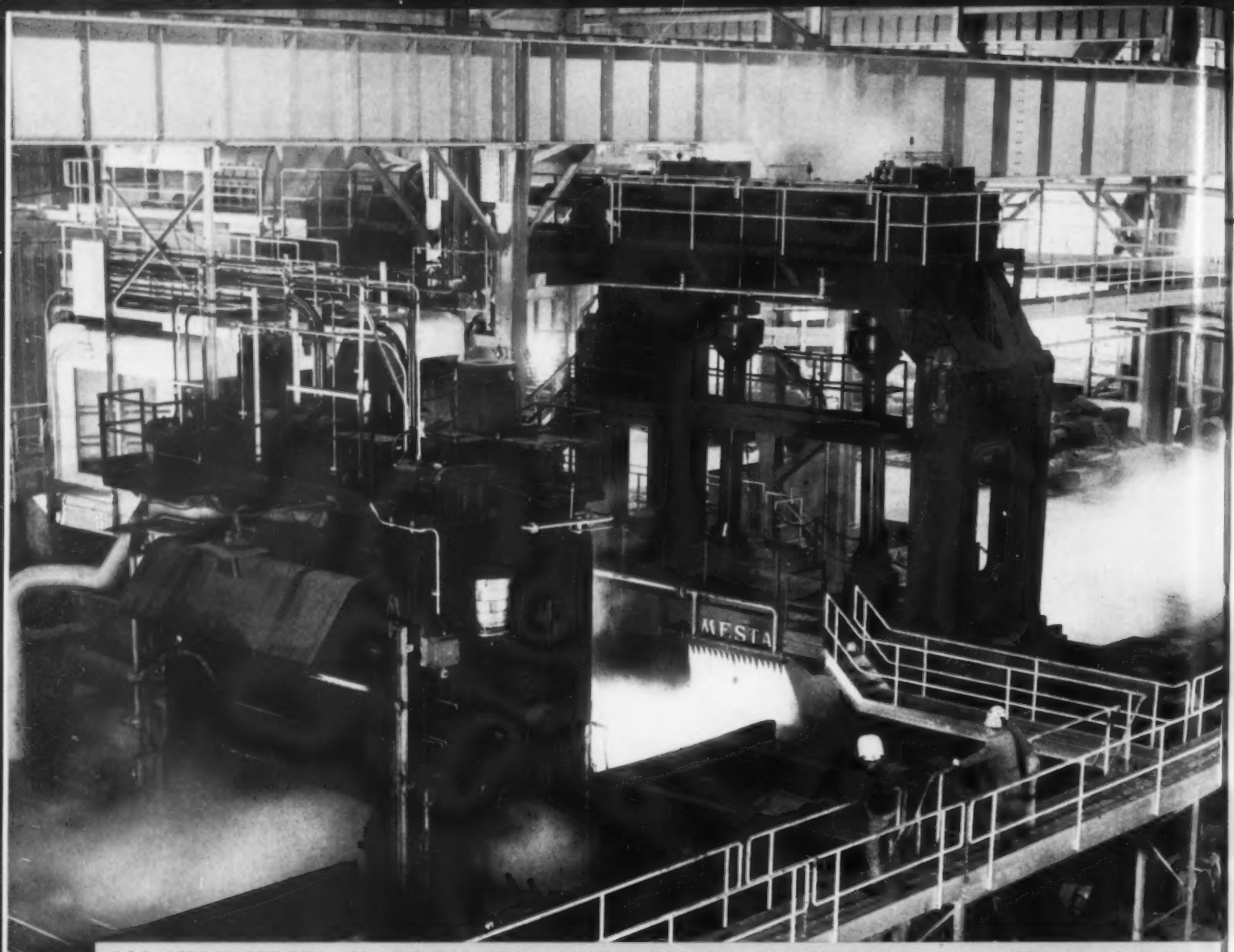


25 x 25 on MORGOIL BEARINGS

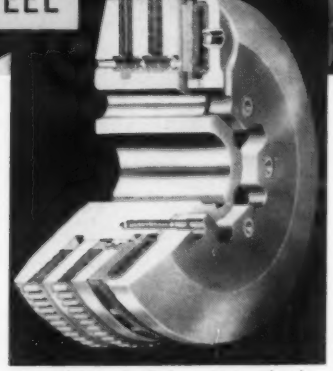
We mean a coil of aluminum foil 25 *hundred thousandths of an inch* thick and 25 *miles* long. High quality coils of this size are routine production on this Four High MORGOIL equipped foil mill at Anaconda Aluminum Company, Louisville, Kentucky.

MORGAN CONSTRUCTION CO., WORCESTER, MASSACHUSETTS

ROLLING MILLS • MORGOIL BEARINGS • GAS PRODUCERS
WIRE MILLS • EJECTORS • REGENERATIVE FURNACE CONTROL



140 INCH MESTA SLABBING MILL WITH COMPACT, POWERFUL WICHITA CLUTCHES ON SCREW-DOWN SETS NEW WORLD STANDARD FOR LUKENS STEEL



Standard Air-Tube Disc Clutch

Outstanding feature of the horizontal mill is the screw-down drive with unique Wichita Clutches.

In place of conventional magnetic or mechanical clutches, are a pair of Wichita Air-Tube Disc Clutches . . . transmitting torques of 9,000 ft.-lbs. to run the screws down. The clutches are normally open and do not rely on electric current for normal mill operation. In addition, they are more compact than conventional clutches and offer many safety features.

For difficult or unusual clutching or braking problems it will pay you to call a Wichita Clutch engineer.

Contact your nearest Wichita Engineer.

Clutch & Control Engineering Co., Livonia, Mich.
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co., Avon, Conn., Philadelphia 44, Pa., and New York, N. Y.
Frank W. Yarline Co., Chicago, Illinois
Larry W. McDowell, Long Beach, California
Andrew T. Lobel, Denver, Colorado
Robert R. King Co., Cleveland, Ohio
Norman Williams, Houston, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri
Donald E. Harman, Dallas, Texas
C. Arthur Weaver, Richmond, Virginia
Malcolm S. Cone, Memphis, Tennessee
Dominion Power Press Equipment, Ltd., Burlington, Ontario, Canada
R. E. Kunz, Seattle 4, Wash.
Norman Rupp Co., Portland 4, Ore.
Bates Sales Co., St. Louis 1, Mo.

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

Foreign Digests

Complete translations from which these condensations were prepared are available from Henry Brutcher, P.O. Box 157, Altadena, Calif., to whom all correspondence should be addressed.

"Reactions in Pelletizing and Iron-Ore Reduction," Part II, by J. O. Edström. Jernkontorets Annaler, v. 142, No. 7. Application of results of studies on single crystals to reduction of rich-ore concentrates and lump ores; microstructures. Reduction of calcium ferrites. Study of processes in reduction of ore pellets and briquets containing hematite and calcium diferrite to throw light on the complexity of the reactions occurring in the reduction of double oxides, impure ores or sinters. Rates of formation and decomposition of calcium diferrite. Reduction rates; reduction of dicalcium ferrite. Reduction of monocalcium ferrite at 1832 F. Reduction of calcium diferrite. Solubility of calcium oxide in magnetite and wustite; and of wustite in calcium oxide. Explanation of discrepancies between author's results and those of Italian workers. Reduction of pellets containing 5 per cent calcium oxide. Reasons for ability of small additions of lime to strengthen rich-ore pellets and to prevent them from swelling. Discussion—Report on similar experiments on a lower-grade ore (65 to 68 per cent Fe, 10 to 6 per cent gangue) conducted elsewhere in Sweden and aimed at producing good pellets for sponge-iron furnaces. Pellets fired at 2190, 2370, 2550 F; their structure and properties; effect of lime additions; firing the pellets in nonoxidizing atmosphere; advantages of firing without oxidation, pellets produced from impure iron ores. (Translation No. 4638)

"Electric Furnace for Fluid-Bed Reduction of Iron Ores," by W. Wenzel, Stahl und Eisen, vol. 79, No. 17. Details on a new economical smelting process for iron ores, based on fluidized-bed reactor technology. Problem of sticking of ore particles: preponderance of carbon phase serving as electrical resistance. Evaluation of four methods of conducting electric current through a system consisting of a fluidized carbon bed, liquid iron and liquid slag. Furnace (200 kw) used for pilot-scale trials; design and operating data. Conclusions drawn from one year's operation of furnace as to power consumption; furnace production: specific output (lb per sq ft of hearth area) compared with that of the blast furnace; product quality. Conditions to be met by the raw materials charged. (Translation No. 4679)

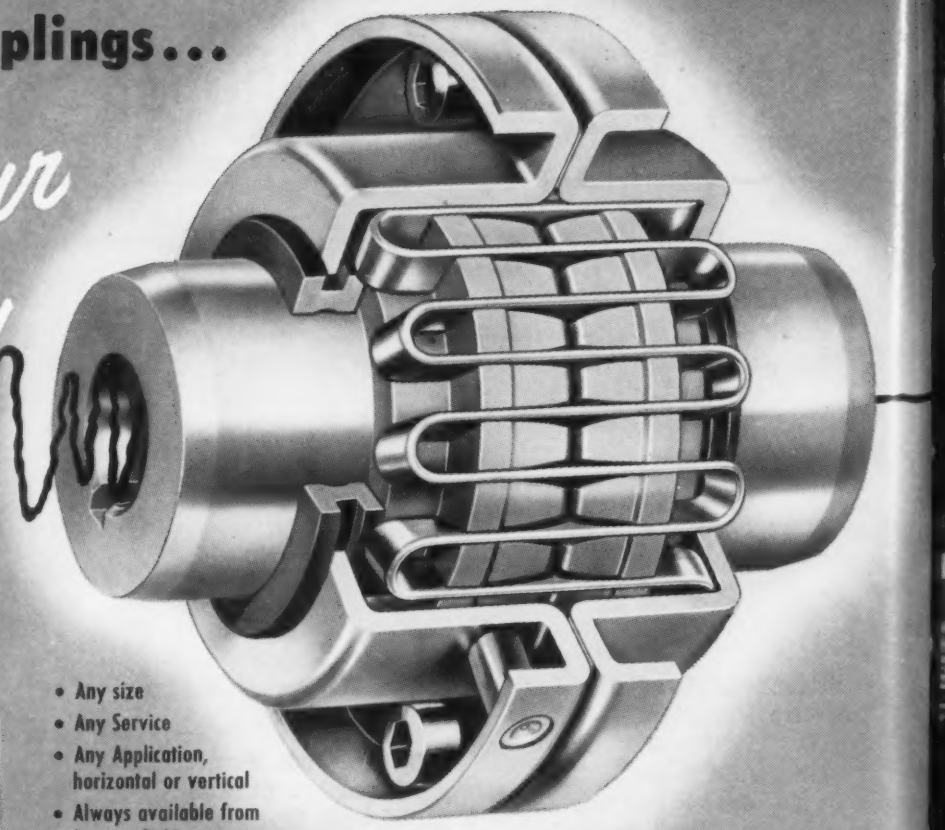
"Study of Deposition and Carry-out of Dust in Steelmaking Furnaces, Using a Scale Model," by M. A. Glinkov and A. L. Serokhvotov. Nauchn. Dokl. Vyssh. Shkol., Metall., 1959, No. 2. Attempt at simulating actual open hearth furnace conditions in a 1 to 15 scale plexiglas model of a 30-ton furnace, with the dust formed from the surface of the bath instead of from the flame. Particulars on model. Measuring technique; measuring points. Results: patterns of dust deposition with straight through-flow and single-ended recycling as against two-ended recycling. Dependence of dust entrainment on dust formation; patterns of dust carry-out under various conditions of flow. Potential usefulness of findings for study of physical aspects of LD process. (Translation No. 4699)

"Operation of Blast Furnace on Sized Fluxed Sinter," by S. K. Trekalo, N. M. Yakubtsiner and A. B. Shur. Metallurg, April, 1959. Operating experience gained at the progressive Cherepovets (near Leningrad) works with screening out the −4 US mesh fraction of fluxed sinter at the bins (not at the sinter plant) and dividing the rest into two size classes (ratio of coarser to finer: 3/2) for better gas permeability of stock column and reduced coke rate in very large blast furnace units. Further recommendations. (Translation No. 4664)

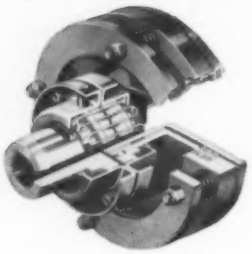
"Annealing of Magnetically Soft Iron," by N. F. Vyaznikov and G. I. Ivanyuk. Metallov. Term. Obra. Met., Jan., 1959. Study of most suitable annealing practice to give technically pure iron high magnetic properties. Effect of annealing temperature on ferrite grain size and coercivity and of annealing time on magnetic properties. Recommended cooling practice from the annealing temperature for highest toughness and maximum magnetic softness. (Translation No. 4480)

Falk Steelflex Couplings...

Protect your machinery in 2 ways



- Any size
- Any Service
- Any Application, horizontal or vertical
- Always available from factory, field or distributor stocks



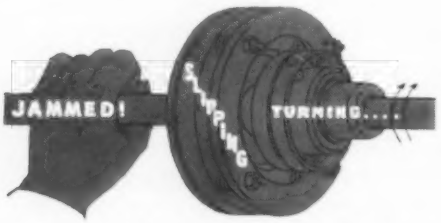
FALK and STEELFLEX are registered trademarks

Falk Controlled Torque Couplings prevent damage from overloads

In applications where danger from overloads exists, use the FALK Type FT Controlled Torque Coupling. The Type FT has all the features and advantages of standard FALK Steelflex couplings—and, in addition, has an adjustable friction slip clutch, enabling the operator to set the coupling to slip at any predetermined overload.

This controlled-torque principle not only prevents transmission of dangerous shocks and limits overloads; it eliminates the breaking of shafts caused by jamming of driven equipment.

An outstanding advantage of the Type FT Coupling is that, as soon as the cause of the overload is removed, the entire coupling will rotate and transmit power without replacing parts or repairing coupling.



There's real economy in using Type FT Controlled Torque Couplings. Many users have reported that these couplings paid for themselves the very first time they slipped (under overload) because of the protection against damaged driving or driven machinery!

...cost less per year of service!

You get *double protection* when you connect your drivin , and driven machinery with a Falk Steelflex Coupling—the all-steel coupling with the exclusive grid-groove design! First, its *torsional resilience* smothers shock and vibration; and second, the Steelflex design prevents damage and lowered efficiency by accommodating shaft misalignment.

Why have increasing numbers of key men in industry standardized on Falk Steelflex Couplings? Their experience has proved that Falk Steelflex Couplings prolong the service life of their machinery... are trouble-free and need minimum maintenance . . . are easy to install, lubricate and disconnect . . . and *cost less per year of service* than ordinary couplings.

One basic Steelflex design—the type F, in its many sizes—is adaptable to more than 90% of all industrial applications. For applications involving danger from overloads, Modified Type FT Controlled Torque couplings (see column at left) are ideally suited. There are numerous other special or dual purpose Steelflex couplings for unusual applications. **Write to Department 247** for engineering bulletin, including selection and dimension tables.

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

FALK

...a good name in industry

MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

single stand reversing plate mill

BLAW-KNOX
PLATE MILLS

Blaw-Knox designs and builds a full range of continuous or single stand reversing plate mills for rolling ferrous and non-ferrous slabs. Other Blaw-Knox equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, sheet and strip processing equipment, electrolytic tinning, annealing, and galvanizing lines, seamless pipe and tube mills, draw benches, and cold draw equipment, Blaw-Knox Medart cold finishing equipment, iron, alloy iron and steel rolls, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings. Blaw-Knox Company. Foundry and Mill Machinery Division. Blaw-Knox Building, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
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Your new plant or expansion idea

Raw materials available?

Right process chosen?

Location correct?

Capacity adequate?

Economically sound?

Readily financed?

Kaiser Engineers designs and builds major facilities for the Steel industry, and is U. S. licensor for the proven L-D Process of oxygen steel making.

Among KE's most valued services are sound, searching economic analyses, feasibility studies and site evaluations. In a word—*Pre-Engineering*—impartial, outside analysis which helps you decide whether to proceed with, defer, or modify the project.

Kaiser Engineers offers you cost-saving, time-saving, one-company service from concept through start-up.

KAISER ENGINEERS

Division of Henry J. Kaiser Company
Oakland 12, California
Pittsburgh, Washington, D. C., Chicago, New York

• KE projects include work in Argentina, Australia, Brazil, Formosa, Japan, New Zealand, as well as Canada and the United States. Assignments range from preliminary planning to plant construction.

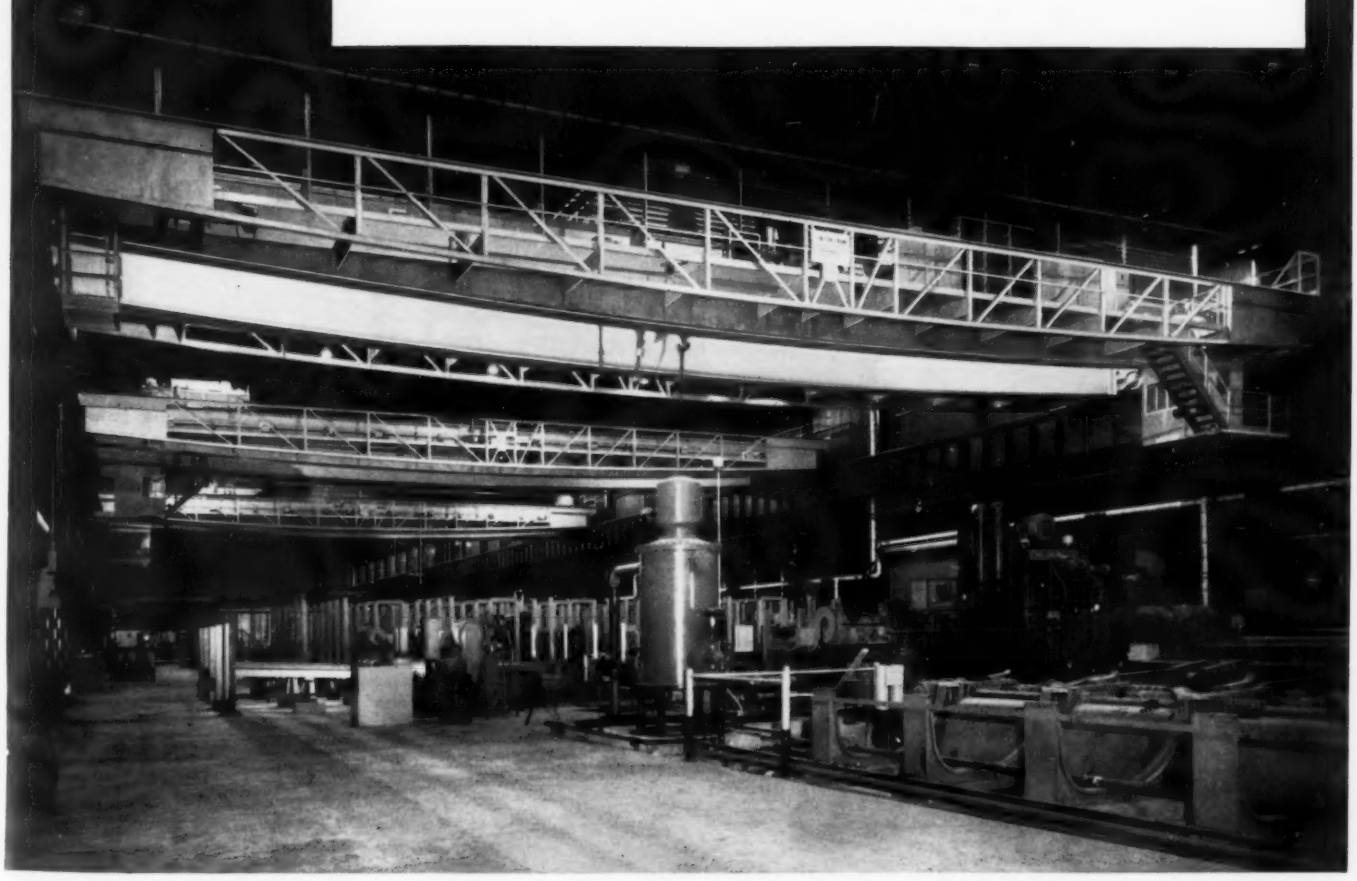
5489-S

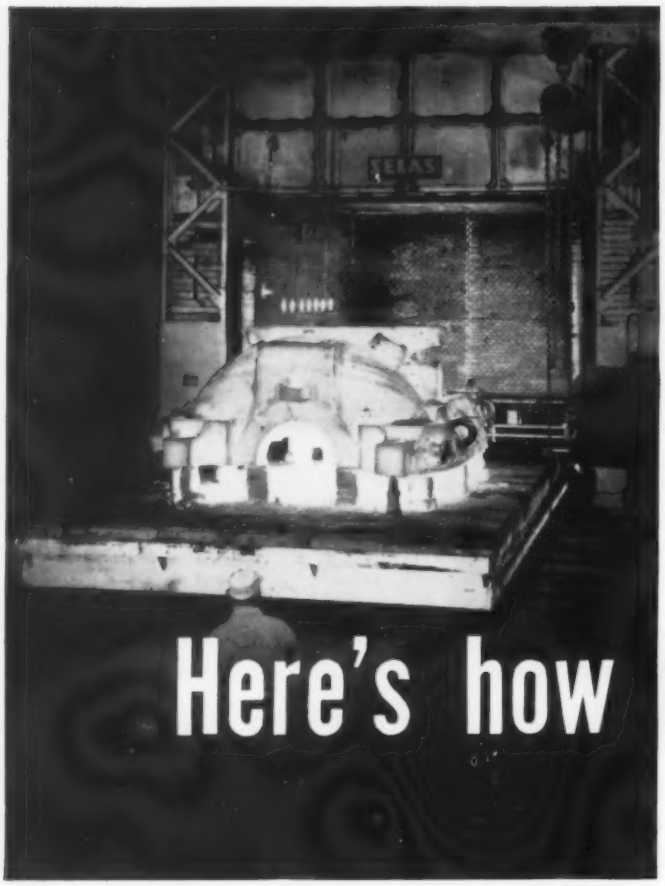
AMERICA'S LARGEST STEEL MILLS USE BROWNING CRANES

Built to A. I. S. E.
Specifications or Your Own

For years, Victor R. Browning & Co. has devoted major time and study to the building of heavy duty mill cranes. The finest materials and workmanship go into the construction of these cranes. All shafts are of the highest quality alloy steel. All bearings are calculated with a proper life factor as required by the A. I. S. E. We will design to suit your special requirements or build to your specifications . . . Victor R. Browning & Co. also makes a complete line of trolleys which can be adapted to existing bridges.

VICTOR R. BROWNING & COMPANY, INC.
WILLOUGHBY (CLEVELAND), OHIO





CASTINGS of high alloy steel are hardened and toughened in Selas Gradiation-fired car-bottom furnace. Picture shows 35-ton turbine shell casting after heating to 1925°F and held at temperature for 10 hr. Turn of valve converts furnace to lower temperature unit for reheat following air-cooling. Time cycle required for this operation reduced 20% through Gradiation fast heat-up and control.

Here's how the Steel Industry u

Throughout the steel industry—in mills and metal-working plants—Selas Gradiation® heat processing is successfully used in many operations. The versatility and adaptability of the Gradiation principle are demonstrated by the diversity of applications shown in the installation photographs on these pages.

Gradiation is a concept and technique of heat processing which coordinates fast, controlled heating with the nature of the workpiece . . . considering its composition, size, shape, heat transfer characteristics and physical properties . . . to develop desired product quality, in minimum time, with maximum efficiency, and with the use of automatic and compact equipment.

Designed and custom-built to meet your specific heat processing needs . . . for hot working . . . galvanizing . . . tinning . . . heat treating heavy sections and special shapes . . . Gradiation equipment contributes production economy, high production rates, ease of handling.

At your convenience . . . without cost or obligation to you . . . a Selas field engineer would welcome the opportunity to survey your needs. For this personal service—or for a copy of our new Bulletin "Selas Gradiation Heating in the Steel Mill"—write to Mr. R. E. Buckholdt, Mgr. Furnace Division, Selas Corporation of America, 42 Dreshertown Road, Dresher, Pa.

Gradiation and Duradiant are registered trade names of Selas Corporation of America

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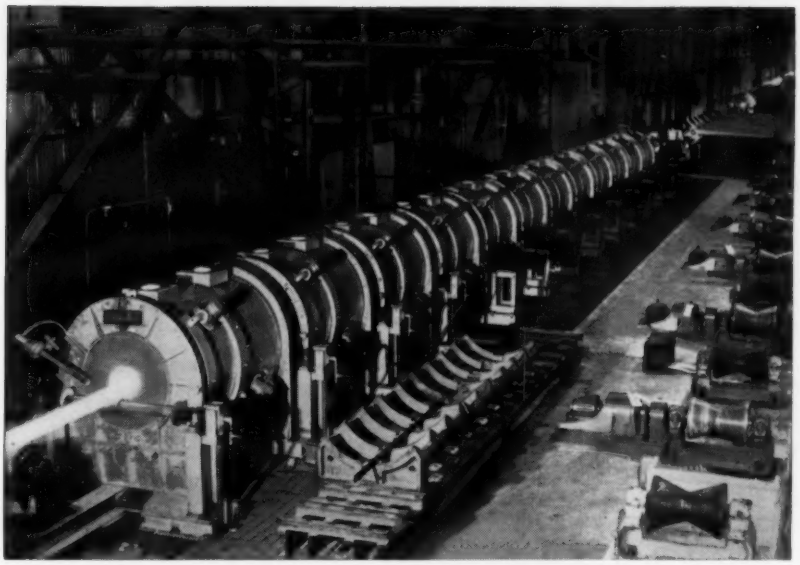
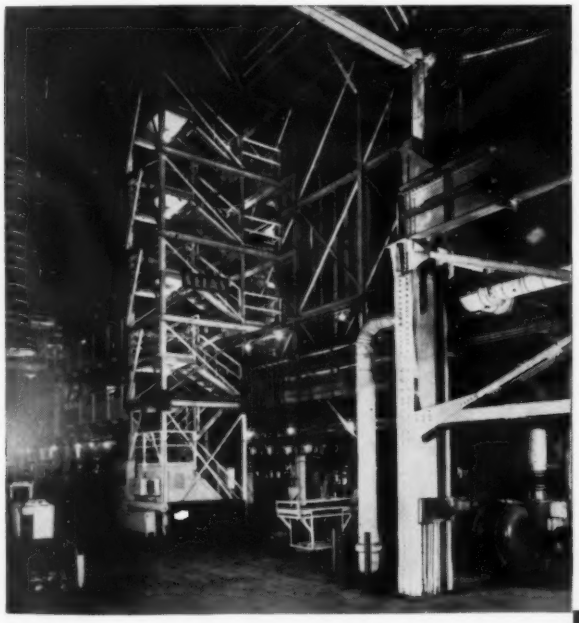


TUBING . . . is normalized and, if required, stretch-reduced in this Selas barrel-furnace line. After forming and welding, the tubing is conveyed through a 48-barrel normalizing line with exit temperature approximately 1650°F. Stretch-mill product proceeds through additional 12 Gradiation furnaces which heat tubing to 1800°-1850°F. Entire process is automated.

y uses SELAS Heat Processing

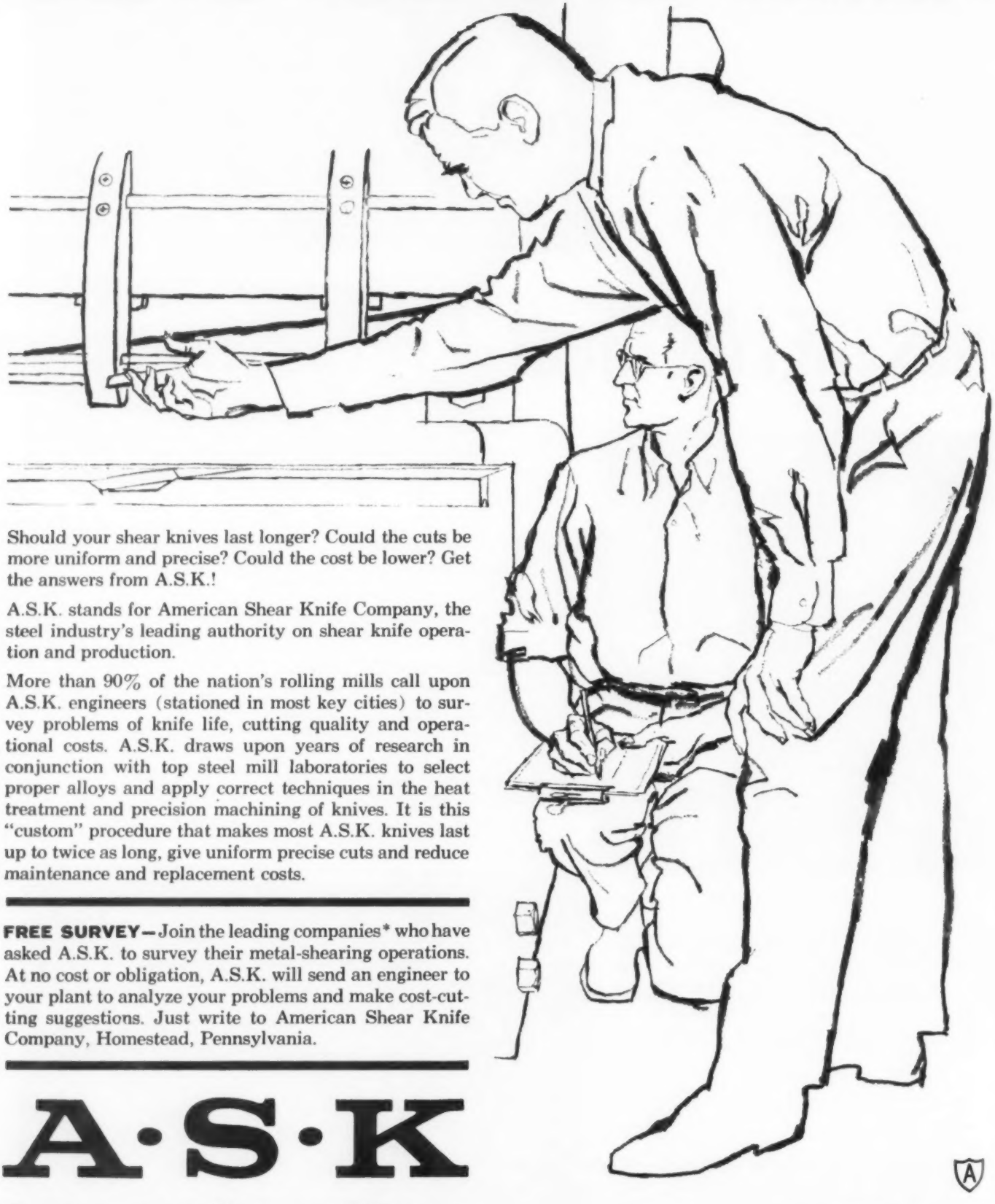


STRIP is continuously bright-annealed in this single-pass, direct-fired furnace. Designed for fast, uniform heating, Gradiation strip lines are compact, easy to install, simple to operate, economical to maintain. This concept of strip heating is also used for annealing of stainless steel, tin reflow, galvanizing-annealing, blueing, preheat for galvanizing and annealing.

TUBE-ENDS are heated for upsetting (for subsequent threading) in this slot-type Selas furnace. As each tube-end is fast heated to 2300°F, the tubing automatically moves down handling table to upsetting machine. Direct-fired Duradiant® gas burners are patterned to assure temperature uniformity within limited area of each tube-end.

Can you get more wear from your shear knives?

A·S·K for the answer!



Should your shear knives last longer? Could the cuts be more uniform and precise? Could the cost be lower? Get the answers from A.S.K.!

A.S.K. stands for American Shear Knife Company, the steel industry's leading authority on shear knife operation and production.

More than 90% of the nation's rolling mills call upon A.S.K. engineers (stationed in most key cities) to survey problems of knife life, cutting quality and operational costs. A.S.K. draws upon years of research in conjunction with top steel mill laboratories to select proper alloys and apply correct techniques in the heat treatment and precision machining of knives. It is this "custom" procedure that makes most A.S.K. knives last up to twice as long, give uniform precise cuts and reduce maintenance and replacement costs.

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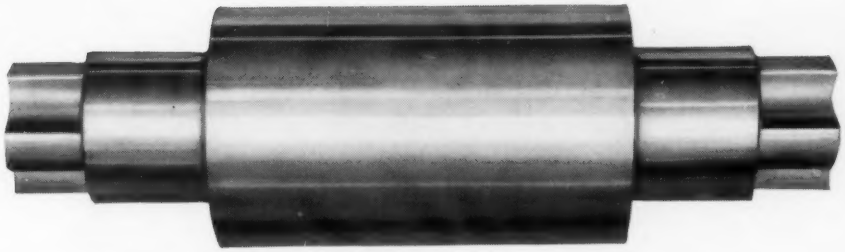
A·S·K

AMERICAN SHEAR KNIFE

**names supplied on request*



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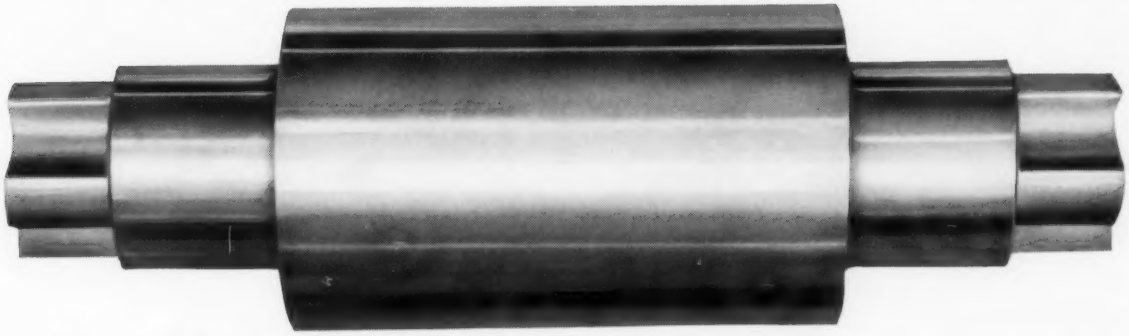
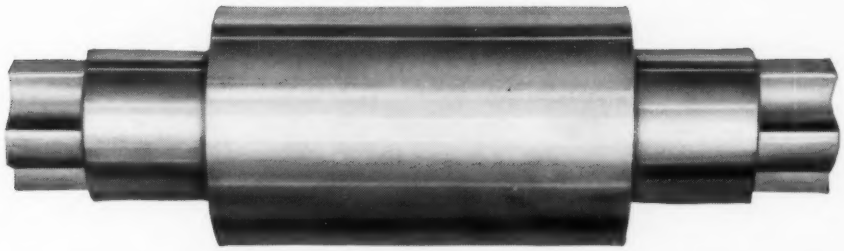


Exactly the SHAPE you order



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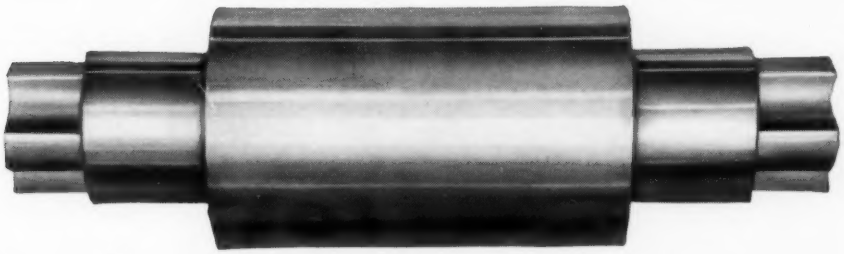

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Messer can work with you to install an oxygen system properly tailored to your own requirements—to make sure your operation is the one ideally suited to increase tonnage and improve the quality of your production.

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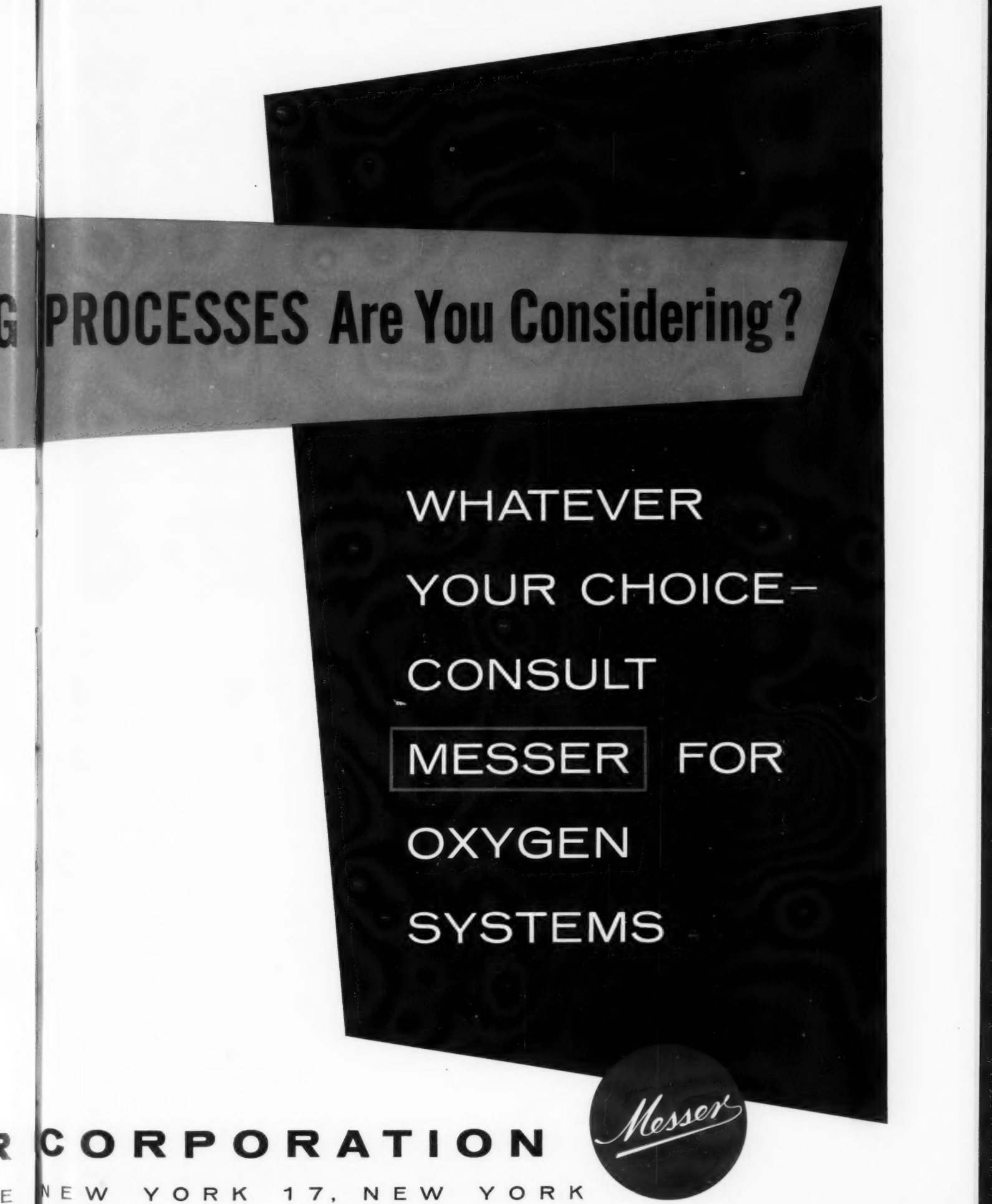
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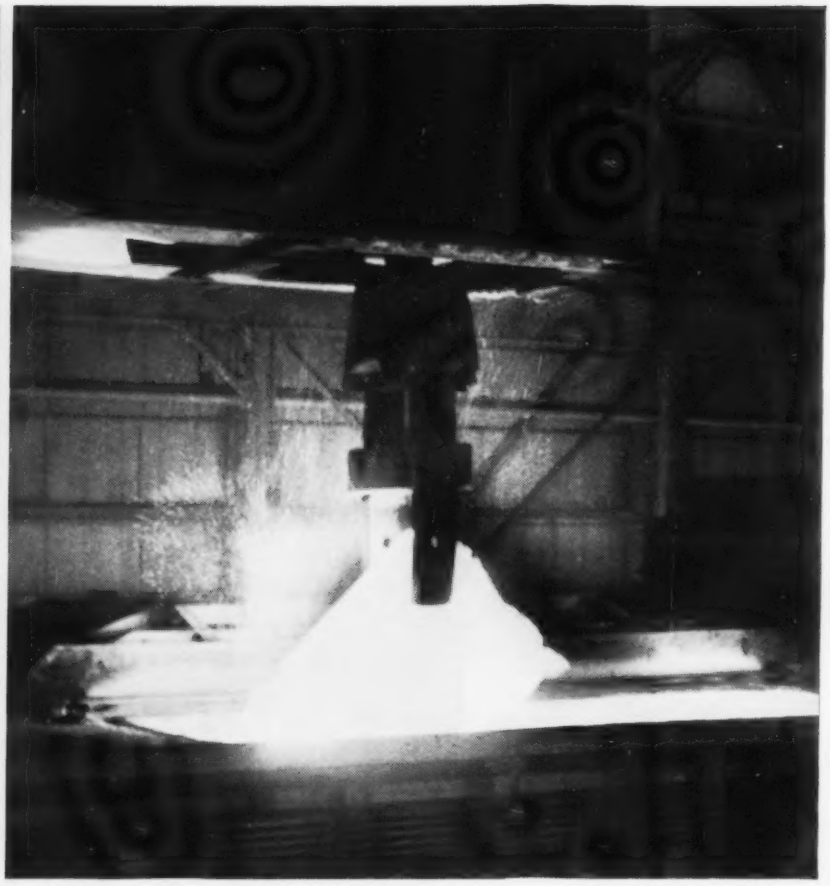
Operator reads Speedomax H chart record



Hot ingot is pulled at Inland

New Trend in Soaking Pit Practice

Accelerated heating of Inland Steel's biggest ingots

Fast heating of giant 20-ton ingots, close temperature control and excellent scale deposition are some of the advantages that Inland Steel is getting from 6 batteries of 18 new Salem-Brosius soaking pits at Indiana Harbor Works.

These advantages are, in part, gained by new accelerated heating systems that feature the Speedomax® Type H temperature controller.

When cold ingots are charged, the pit operator sets a predetermined accelerated heating program by means of a timer on his central control panel. During the period of fast heating, extra fuel is supplied to the pits, driving pit temperature to an accelerated control point. This higher point is determined by metallurgical conditions and may be reset as conditions demand. As the ingot soaks up this extra heat, and the fast-heating period is completed, fuel is cut back and Speedomax H returns the pits to normal control temperature for the remainder of the soak period.

Because of this efficient control system, heat-up time is cut and the production of ingots is increased, assuring that the new rolling mills can operate at maximum output.

Because of their reliability, L&N temperature control instruments are specified by a majority of soaking pit users and manufacturers. So, when you modernize—or build soaking pits—ask your L&N Field Engineer to show you what L&N temperature controls . . . and our equally dependable combustion controls . . . can do for you. Or write to 4942 Stenton Avenue, Phila. 44, Pa.

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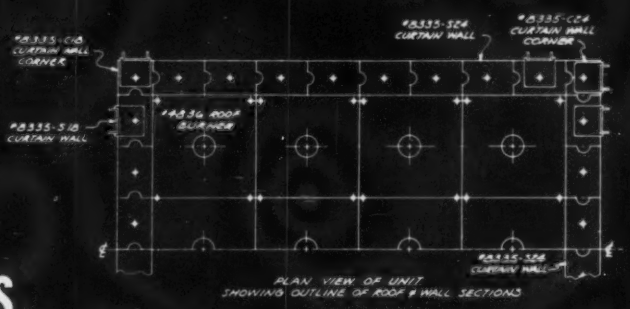
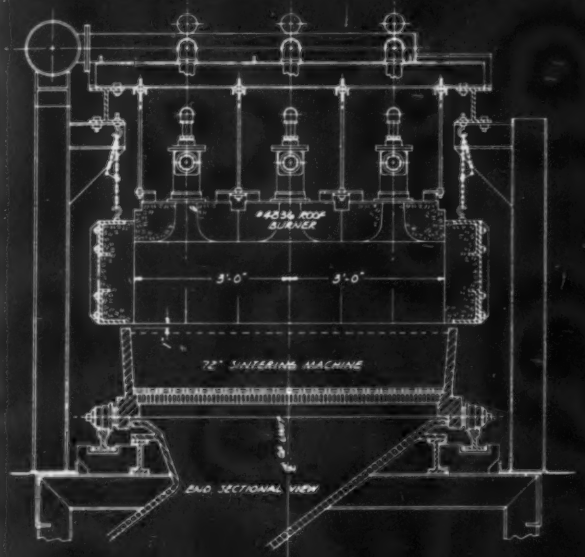
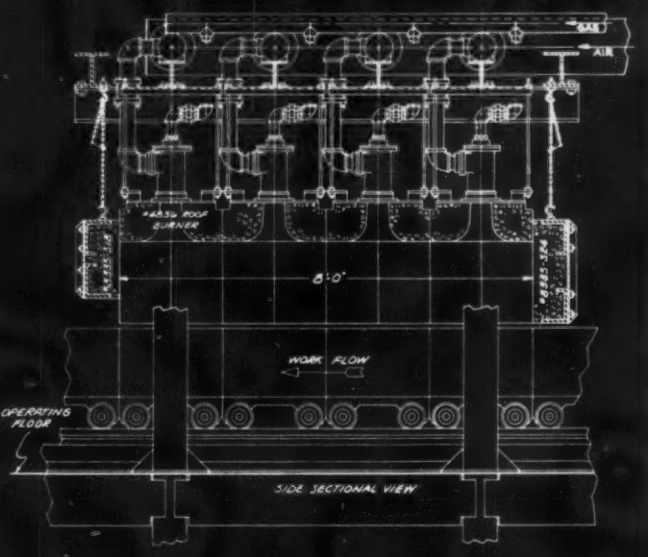
Build your Sintering Ignition Furnace with NORTH AMERICAN Roof Burners & Curtain Walls



PLAN VIEW OF UNIT SHOWING OUTLINE OF ROOF & WALL SECTIONS





Curtain height adjustable for best clearance.

Combustion products are more concentrated at side and end walls with high downward velocity acting as an air curtain to exclude cold outside air. This high velocity helps shield the refractory from iron dust and popping.

Fuel input is uniform across the bed.

Nozzle mixing type burners can use coke oven or natural gas without danger of flashback. Light oil standby available.

Burners are stable with large amounts of excess air.

High flame propagation rate permits inputs as high as 600,000 Btu per hr sq ft assuring good ignition even with self-fluxing sinter.

Water cooled support beams are not required.

Burner flames are adjustable from flat along the roof (for maximum radiance) to conical, overlapping at the bed.

Wall sections can be quickly and easily replaced without major shutdown.

Extra rows of burners and extra curtain walls can be added easily to increase the size of an existing hood.

Patent Pending

NORTH AMERICAN for COMBUSTION and Hydraulic Controls

Call your nearby North American engineer or write to

The North American Mfg. Co.
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Persons in the know
are specifying fuses

HATFIELD Electric Co.,

a leading electrical contractor,
installs–

FUSETRON dual-element Fuses

in its new office building

Mr. Brown, Vice-President tells why . . .

"For our own buildings and our recommendations to our industrial and commercial customers, we feel that FUSETRON fuses are the most reliable means of over-current protection that has been made available to us.

"We require protective devices for industrial and commercial application that not only provide adequate short-circuit protection but also protect against needless blows. In dead-front panel equipment it is especially desirable that they operate cool and efficiently. Of course FUSETRON fuses provide this.

"The additional protection features of these devices are of continual interest to our customers, and we feel their use is to our mutual benefit.

"As a matter of further interest, we are remotely mounting the fluorescent ballasts throughout our own offices and adding your fuse blocks with indicating FUSETRON fuses for better protection and lower maintenance."

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This Hatfield Electric Co. installation underscores the need for . . .

LIFE-TIME DEPENDABILITY AND HIGH INTERRUPTING CAPACITY IN A MODERN PROTECTIVE DEVICE — *You Get Both With* FUSETRON Fuses . . .

THERE IS A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED

Mains and Distribution Panels — Protected by FUSETRON dual-element fuses.

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Architect: Dalton-Dalton Associates.
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SAFE PROTECTION THROUGH THE YEARS . . . without maintenance or recalibration costs.

FUSETRON fuses remain safe and accurate because, unlike mechanically operated devices, they have no hinges, pivots, latches or contacts to stick or get out of order.

FUSETRON fuses are *calibrated at the factory by engineers.* Once properly installed, they require no maintenance — no periodic inspection and accompanying down-time.

PROTECT AGAINST HIGH FAULT CURRENTS

A modern protective device must provide protection against today's heavy fault currents — and be able to protect against even greater fault currents that might develop in the future.

You get this protection with FUSETRON fuses. FUSETRON dual-element fuses have an interrupting rating of 100,000 amperes rms symmetrical.

Electrical Protection goes MODERN with FUSETRON fuses because they are adequate for today's conditions and for anticipated growth in service demands.

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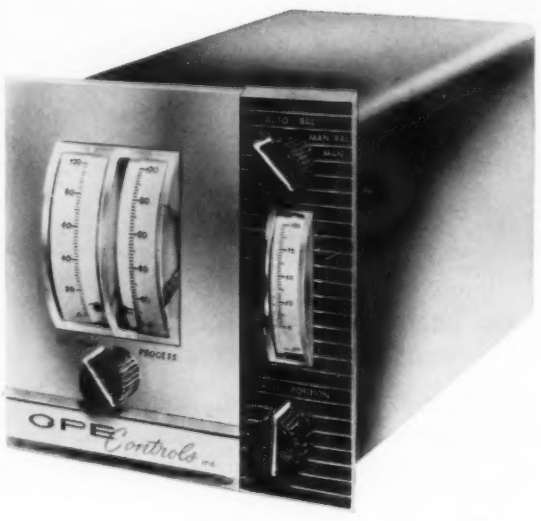
Electronic controllers for high-performance systems!

The new **GPE Controls** R465 Electronic Controller is built for high performance in every aspect... the result is the **highest degree of dynamic accuracy** possible. Three times as fast as other known control systems, yet comparably priced. With GPE Controls electric transmitters and electro-hydraulic valve actuators, precise control can be maintained at more than 20 cps. Easy, low-cost installation, because high-level d.c. signal makes possible simple unshielded wiring. Instant visual comparison of parallel set-point and process variable indicators.

GPE Controls R465 Electronic Controller features advanced functional design throughout. Controller drawer (left) and manual/automatic station (right) are housed in a dustproof mounting case. Either section may be serviced while the other controls the process. Proportional band, rate, and reset controls are accessible from the front while controller is operating, and are calibrated in logarithmic steps for ease in adjusting to process dynamics.



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NEW factual bulletin tells the "how and why" of electronic control. Write for your copy today!

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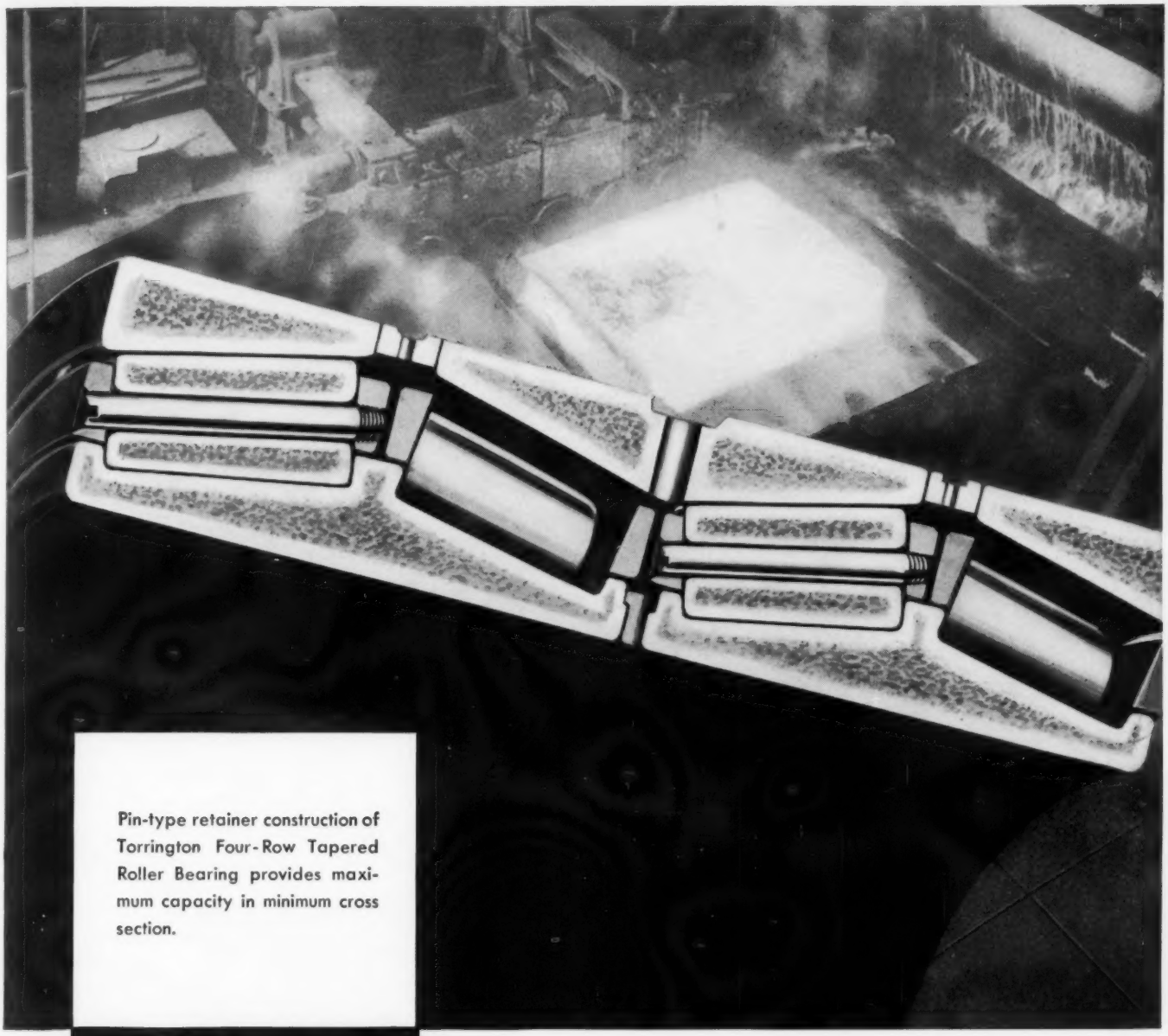
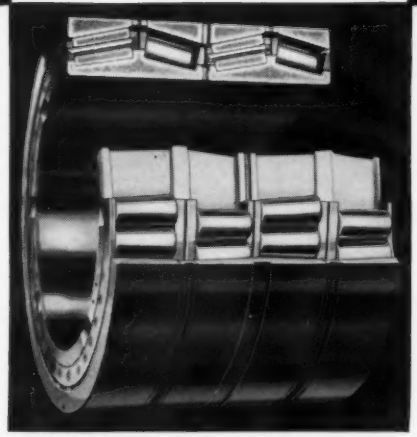


Pin-type retainer construction of Torrington Four-Row Tapered Roller Bearing provides maximum capacity in minimum cross section.



For Maximum Capacity and Life Expectancy
Torrington Roll Neck Bearings

In design, selection of materials and precision construction, Torrington spares no detail to insure maximum bearing capacity and life expectancy in roll neck bearings.

For example, where rolling mill window openings and roll diameters limit roll and bearing dimensions, Torrington design provides for minimum bearing cross section and maximum roll neck diameters. Rollers are longer and pin-guided to allow closer spacing and greater area of contact surface, providing a much greater load capacity.

Care in such details, and in proper selection of the *right* bearing for your application, pays off in tonnage rolled. For most satisfactory performance, make Torrington Bearings your selection. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

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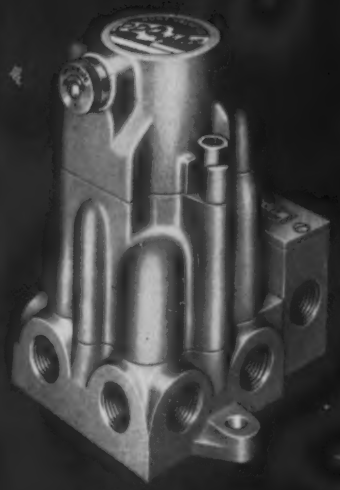
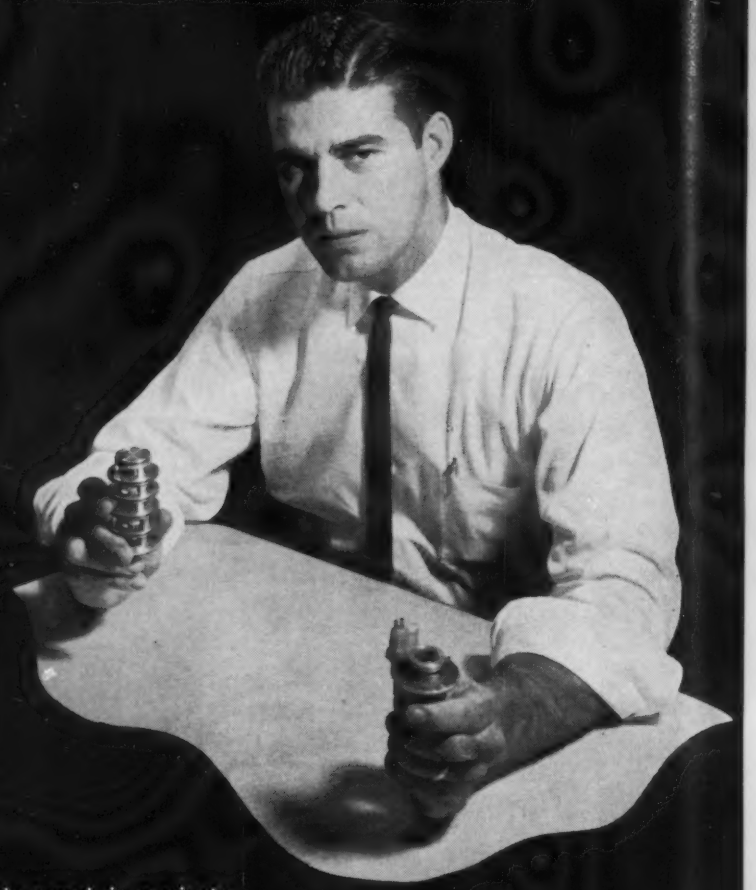
IF IT'S A HUNT PDQ AIR VALVE





You want an air control valve that **one man can completely repack in a minute** on the bench or on the line.

We have that valve for you.

To repack the HUNT PDQ you just slide two simple self-contained units into place. One . . . the poppet spindle-sleeve assembly. Two . . . the plug-in solenoid pilot assembly. That's all!

You want a minimum inventory of spare parts. With the HUNT PDQ valve you stock **only two spare units** . . . not several dozen parts.

One man . . . any man . . . can completely repack the PDQ (including the solenoid pilot section) in less time than it takes you to read this ad. And your line is back in operation again.

This is the valve you want and need. Write today for the full story on the PDQ.

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A. V. Ney, Sales Manager

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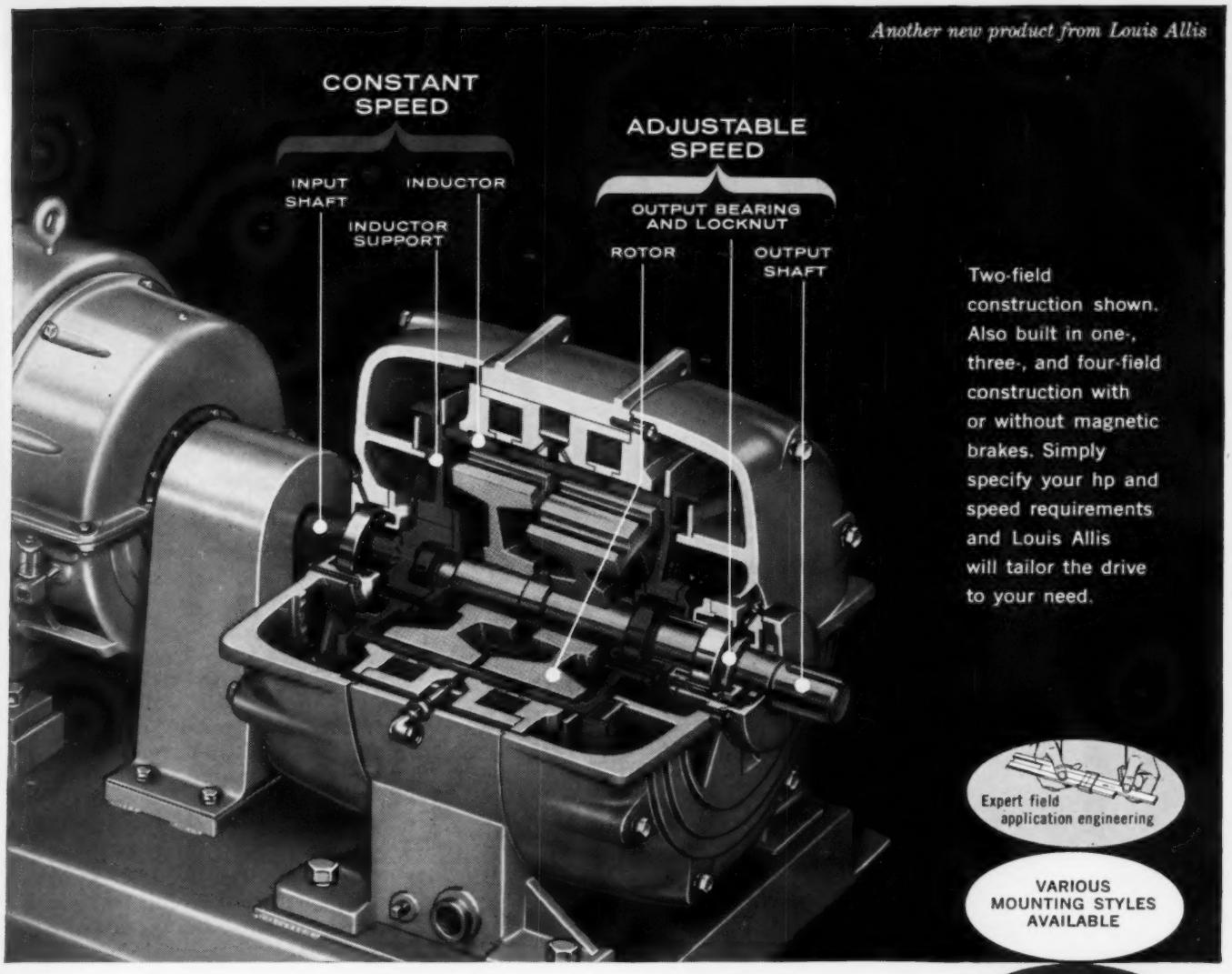
- ☑ Accessibility
- ☑ Simplicity
- ☐ Speed and Capacity
- ☐ Price and Quality

The Hunt PDQ valve tops them all in every class.

Next month . . .
the SPEED and CAPACITY story.

HUNT HVC ***Quick-As-Wink*** AIR & HYDRAULIC CONTROL VALVES

Another new product from Louis Allis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Two-field construction shown. Also built in one-, three-, and four-field construction with or without magnetic brakes. Simply specify your hp and speed requirements and Louis Allis will tailor the drive to your need.
Expert field application engineering
VARIOUS MOUNTING STYLES AVAILABLE

The new Louis Allis MAGNETIC DRIVE

A compact, adjustable speed drive up to 2000 hp!

Based on a liquid-cooled magnetic coupling design, the *all-new* Louis Allis Magnetic Drive offers you the finest in precise regulation, compactness, and design flexibility for adjustable speed drives up to 2000 hp.

A unique annular cooling manifold provides effective heat transfer. It eliminates "water-drag" since there is *no* liquid in the air gap between the constant-speed and adjustable-speed members. There's no "flooding" the Magnetic Drive or forcing of water into bearings. And you'll *never* find condensation in the bearings. The reason: a planned flow of air through the drive reduces bearing temperatures and exhausts any condensation which might occur as the unit cools off after use.

Stationary field construction eliminates slip rings. All bearings can be lubricated without disassembly, and grease chambers provide ample grease reservoirs. Coils and lead connections are encapsulated in a chemical- and heat-resistant polyester — and simplified construction eases inspection and servicing. The *all-new* design permits simple relocation of cooling inlet, conduit box, discharge, etc., regardless of direction of rotation.

If your plans call for adjustable speed drives — specify Louis Allis Adjustable Speed Magnetic Drive. Write for a copy of Bulletin 3650 — now available at your Louis Allis District Office, or from The Louis Allis Co., 450E. Stewart Street, Milwaukee 1, Wisconsin.

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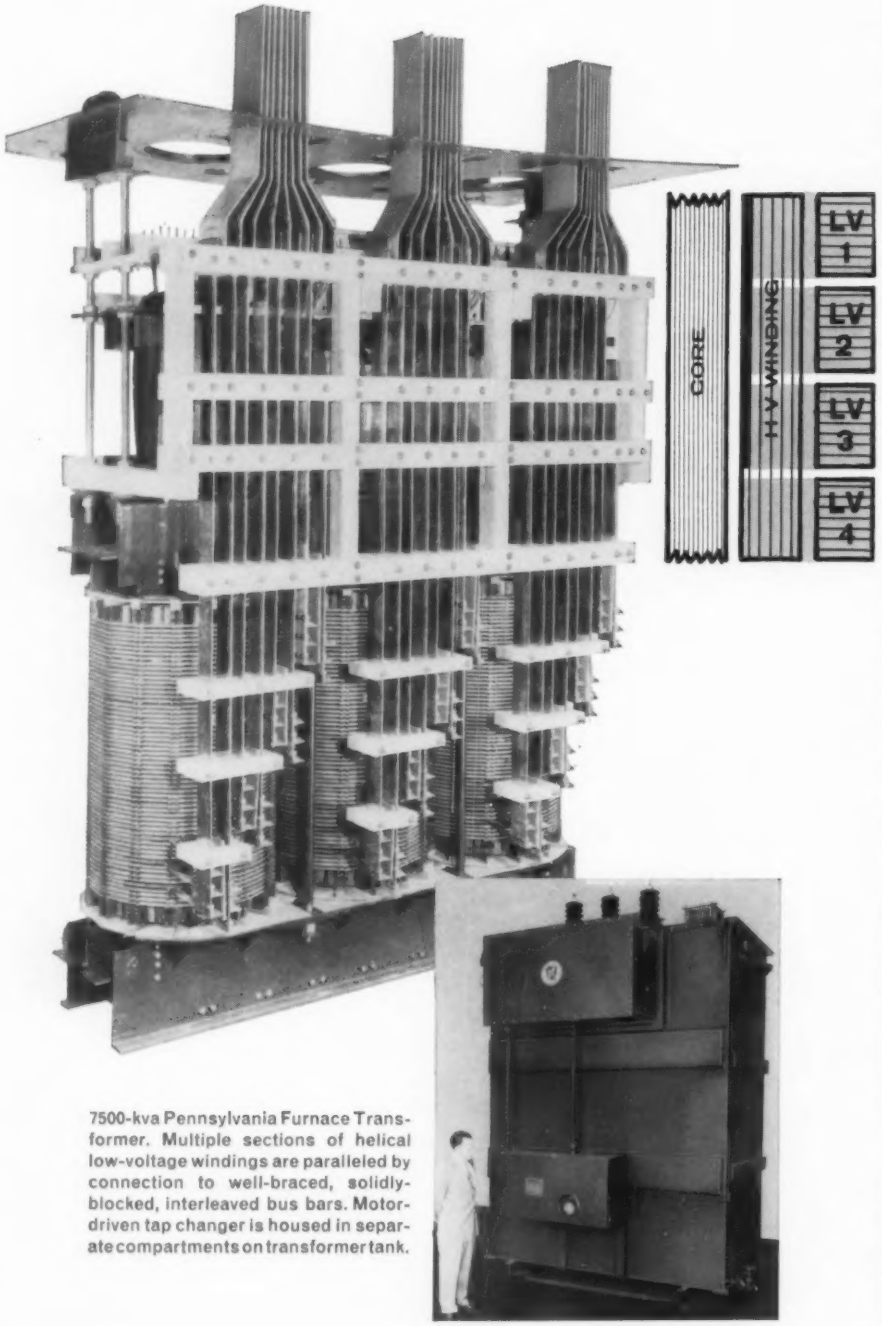
MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

ASD-135

In a quarter-of-a-century...

there has never been a failure in the helical-type secondary winding of a Pennsylvania Furnace Transformer



7500-kva Pennsylvania Furnace Transformer. Multiple sections of helical low-voltage windings are paralleled by connection to well-braced, solidly-blocked, interleaved bus bars. Motor-driven tap changer is housed in separate compartments on transformer tank.

Since 1936, when Pennsylvania introduced a new type of helical winding for the low-voltage coils of furnace transformers, there has *never* been a low-voltage winding breakdown on any Pennsylvania Furnace Transformer using this design. Here are a few of the reasons:

1. Magnetic balance is established with a sectionalized low-voltage winding. As indicated by shaded areas in the accompanying sketch, this balance is maintained section-by-section even with portions of the layer-wound high voltage winding tapped out (black area), since no distortions are created in the magnetic pattern.

2. Internal forces are low as a result of the above method. To protect further against axial short-circuit forces, coils are hydraulically compressed with a force equal to the maximum short-circuit force that might occur in service. The circular shape of the coils prevents distortion from radial short-circuit forces. Coils receive a multiple treatment of thermo-setting adhesive which securely bonds the coils together. Then they are clamped and braced in the core frame so that no deformation or displacement can occur.

3. Current balance is maintained by progressively transposing the multiple low-voltage conductors in such a way that a complete transposition is made in each section, regardless of the number of turns or sections.

4. Bus bars of opposite polarity are interleaved to reduce reactance and improve current distribution. They are well braced to prevent deflection and incidental contact during short circuit.

* * *

Briefly, these are some of the factors that account for the outstanding trouble-free performance of Pennsylvania Furnace Transformers in gruelling day-in, day-out service. To take advantage of this service-proved reliability... please contact Pennsylvania Transformer Division, McGraw-Edison Company, Box 330, Canonsburg, Pa.

PENNSYLVANIA FURNACE TRANSFORMERS McGRAW EDISON

Oxygen And Steelmaking Processes

A Comparison of Open Hearth, LD, Kaldo and Rotor Processes

by E. F. KURZINSKI, Manager,
Applied Research and Development,
Air Products, Inc., Allentown, Pa.

Regardless which of the many new steelmaking techniques is adopted by the steel industry, oxygen is sure to play a major part in the processes.

WORLD steelmaking capacity is expected to increase approximately 10 per cent by 1965. A major portion of this expansion will be effected by installation of pneumatic steelmaking.

In 1965, the oxygen-equipped open hearth will remain the dominant steelmaking furnace. Benefits of oxygen for increasing open hearth output have been proved. Substantial oxygen capacity has been installed and more will be required to provide for additional open hearth usage. Intensive experimentation presently underway will result in further increases in steel production rates and oxygen consumption.

Oxygen steelmaking processes will produce at least 20 per cent of total steel in the United States by 1965. Growth of these processes will be greater in other areas of the world. Of all the oxygen processes, LD has found greatest acceptance. Kaldo and Rotor processes are not presently used in production in this country, and only to a limited extent in other countries. These oxygen processes require approximately 2000 cu ft of oxygen per ton of steel.

STEEL CAPACITY AND EXPANSION

Annual steel capacity in the United States will increase to approximately 160,000,000 tons by 1965 from a capacity of 147,634,000 tons in 1959. This increase in capacity is necessary to provide for the expected population growth and increased steel consumption per individual. Expansion in steel capacity can be accomplished by increasing the production rate of existing open hearth furnaces with oxygen or by installation of new oxygen processes such as the LD, Kaldo, or Rotor furnace. Considering that labor costs represent an increasing proportion of production costs, the steel industry is concentrating on methods which reduce labor costs and is installing those new processes which promise reduced capital and operating costs. For a specific steel mill, the method selected for increasing capacity will depend on a number of factors which must be carefully evaluated for the specific conditions existing in that mill.

DESCRIPTION OF OXYGEN STEELMAKING PROCESSES

Open hearth process—Today the major portion of steel is made by the open hearth process and this process will continue to provide the major portion of steel production for the foreseeable future.

Oxygen is finding widespread use in the open hearth process to increase production rates. Effectiveness of oxygen use was proved shortly after World War II. In this experimental work, an open hearth furnace operated with oxygen addition into the checker air, through end burners for combustion and through roof lances for direct oxidation, produced 33 tons per hr tap-to-tap compared to 16 tons per hr tap-to-tap with ore practice on the same furnace.

Although over ten years ago it was proved technically that oxygen addition markedly increased open hearth output, oxygen practices were not incorporated in production because of unfavorable economics. Ad-

vances in the technology of oxygen production with attendant reduction in oxygen cost since that period have made possible increased acceptance of oxygen as a tool for increasing open hearth production. Today many open hearths produce 30 to 45 tons per hr tap-to-tap using oxygen roof lances and basic roofs. Experimentation presently underway on improved techniques for oxygen addition through roof lances and end burners will improve on this production rate. Conceivably open hearth furnaces can produce in excess of 60 tons per hr tap-to-tap in continuous production. Several shops already have exceeded this tonnage rate where the furnaces were given preferential treatment.

Roof lance and flame enrichment oxygen is relatively simple to apply. A schematic of these practices is shown in Figure 1.

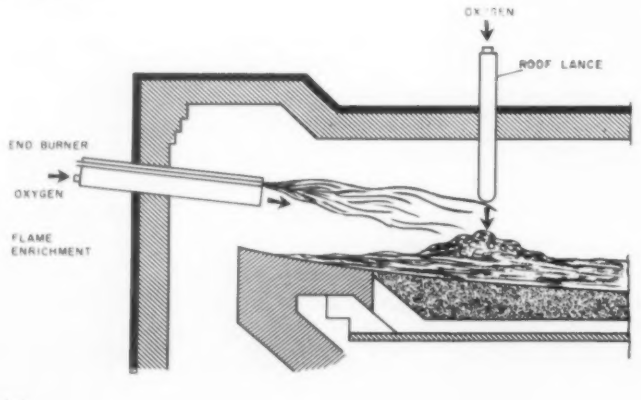
Production increases of 20 to 35 per cent are immediately evident following application of roof lance oxygen. Only minimum experimentation is required to develop a satisfactory practice. Oxygen can be added through one, two or three roof lances although the steel industry is presently concentrating on the use of two roof lances.

Technique of oxygen addition depends upon the conditions existing in the individual open hearth shop. Practices presently in use begin oxygen addition ½ hr before hot metal, immediately after hot metal, or ½ hr after hot metal. Usual practice is to start oxygen immediately after hot metal. Flow rate depends upon the furnace design and can vary from 20,000 to 40,000 cu ft per hr per lance. At the present time in the United States, roof lance practices consume between 450 and 700 cu ft of oxygen per ton of steel. For maximum oxygen efficiency, the lances should be positioned from the slagmetal interface to 6 in. above the slag surface. Oxygen addition is continued until tap carbon is reached.

Lances, which may be of varied design, are under intensive study. Lances are water cooled and fabricated primarily of steel tubes except for a cast or forged high conductivity copper tip. The roof lance generally incorporates six orifices. The orifices vary between ⅜ and ⅝ in. diam. Optimum lance design has not been developed yet, although present designs are entirely satisfactory from an economic standpoint. Figure 2 shows typical roof lance designs.

Many steel mills introduce oxygen through a separate tube located immediately below the atomized fuel stream in the end burner, a practice called flame enrichment. By adding oxygen immediately below the

Figure 1 — Schematic shows open hearth process with roof lance.



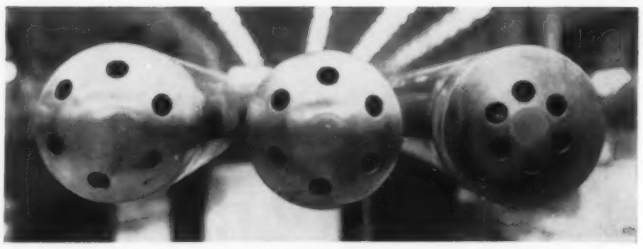


Figure 2 — Typical roof lance designs are shown here.

atomized fuel stream, a highly radiant zone is created on the underside of the burner flame. By this technique heat transfer is increased greatly to the steel scrap without materially increasing radiation to the furnace roof. Thus scrap melting is accelerated without incurring roof damage.

Generally, flame enrichment is used only during scrap meltdown although some mills use flame enrichment, as required, during the refining period. Flow rates vary between 10,000 and 30,000 cfhr. Consumption for flame enrichment varies between 250 and 450 cu ft of oxygen per ton of steel. Open hearth production is increased by between five and ten per cent. Recent information in Russian literature indicates that under certain shop conditions, addition of combustion oxygen up to 1000 cu ft per ton of steel increases steel production by 40 per cent. As yet, the value of this practice has not been confirmed by steel mills in the United States.

LD process—For many years considerable interest was evidenced by steel producers in developing a method which would combine the high production rate of the bessemer converter with the better quality product of the open hearth. The obvious method to minimize nitrogen in the steel was to eliminate nitrogen in the oxidizing gas, but introduction of pure oxygen into a bessemer converter resulted in excessive refractory damage. The maximum enrichment level attained without increased refractory damage was 35 per cent oxygen, but at this level the nitrogen dissolved in the steel was still excessive.

A major step was the introduction of pure oxygen through a water-cooled lance positioned above the molten metal bath—the LD process. Practical development of the LD process was carried out shortly after World War II in two Austrian steel mills: Vereinigte Osterreichische Eisen-und Stahlwerke AG, Linz, and Oesterreichisch-Alpine Montangesellschaft, Donawitz.

The LD process which is extremely simple is shown schematically in Figure 3. High-purity oxygen is injected through a single-orifice, water-cooled lance onto molten iron which has been previously charged into a closed-bottom, basic-lined converter vessel. The converter mouth can be eccentric or concentric in design. Working lining is generally a tar-bonded dolomite. The basic-lining makes it possible to permit removal and control of phosphorous and sulphur. Lance position is not too critical. Lance life varies from 80 to 2000 heats and depends on vessel size, cooling water flow and height above the bath among other factors. Average lance life is about 500 heats.

First LD converters tapped about 30 tons with a blowing cycle of 20 minutes. Tap-to-tap time averaged 35 min. With additional experience, vessel size was in-

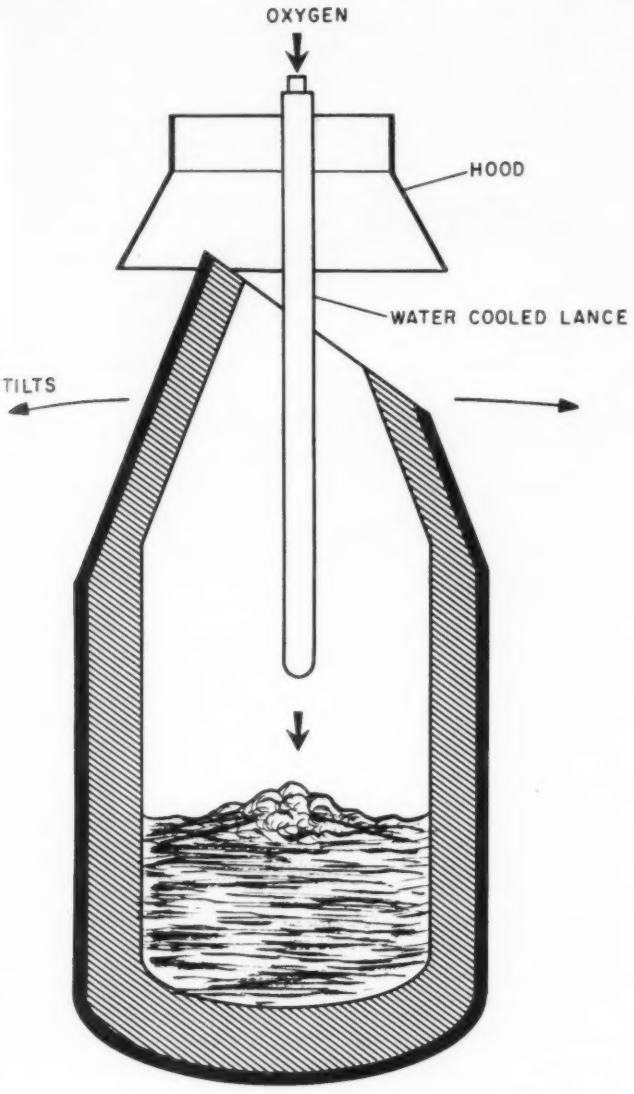


Figure 3 — Schematic shows LD process.

creased. Early in 1959, Jones & Laughlin Steel Corp., Aliquippa Works, averaged slightly over 83.5 tons of steel with a 20.8-min blowing cycle and a 46-min tap-to-tap time. This averages to about 108 tons per hour tap-to-tap. Oxygen consumption was 1580 cu ft per ton of steel.

Oxidation reactions in the LD converter are complete and predictable. Thus it is possible to "catch" carbon by taking into consideration the chemistry and weight of the charge and the duration and rate of oxygen blow. In the LD process, slightly more than the theoretical requirement of oxygen to oxidize the metalloids is needed.

A wide variation in hot metal composition can be tolerated when using the LD practice. Charging temperature of the hot metal is not critical. The exothermicity of the oxygen reaction with the metalloids raises the temperature of the bath quickly once a "light" is established.

The high reaction temperatures associated with the LD process permit high lime charges and basicity and makes possible the production of low sulphur and low phosphorous steels. For treating high phosphorous iron to produce low phosphorous steel, two and three-slag processes are used.

An assured supply of oxygen is of paramount importance. An interruption in the oxygen supply results in complete stoppage of the steel plant. Oxygen purity must be high. Nitrogen is the impurity which causes difficulty; if the impurity is argon or other rare gas, steel quality is not impaired. In one steel plant, controlled tests indicated that use of 99.4 per cent oxygen resulted in a nitrogen content of 0.0025 per cent in the steel. When the oxygen purity was reduced to 99.2 per cent the nitrogen content in the steel increased to 0.0035 per cent. In experimental tests in a 10-ton vessel using a 50 per cent oxygen-50 per cent nitrogen mixture, the steel nitrogen content averaged 0.008 per cent with a range between 0.006 and 0.018 per cent depending on variations in charge composition and lance height. During 1958, nitrogen in the steel at Jones and Laughlin averaged 0.0031 per cent using 99.5 per cent purity oxygen.

Economics associated with the production of LD steel depend upon local conditions. Labor, refractories, oxygen and scrap-hot metal ratio must be included in the economic study. In almost all cases, however, the LD converter proves to be considerably lower in cost than the open hearth in initial investment and operating costs.

Kaldo process— In Sweden, a new technique using oxygen in a rotating converter has been successfully evolved from small experimental tests to a 30-ton experimental production unit. This method of steelmaking, the Kaldo process, was developed by Stora Kopparsbergs Bergslags, A. B., Domnarvet, Sweden.

Figure 4 is a schematic representation of the Kaldo process.

In the Kaldo process, a closed-bottom converter is rotated about its longitudinal axis; this longitudinal axis being inclined at an angle of 17 degrees from the horizontal. The charging end of the converter has a concentric opening. The vessel presently in use has a 30-ton capacity and the process time is about two hours. Processing time depends on hot metal chemistry.

The 30-ton converter in use in Domnarvet has an 11 ft-5 in. diam and is 18 ft-0 in. long. The rotating vessel has two running rings resting on four supporting wheels in a heavy cradle which can be turned about two trunnions like a standard converter. The working lining is tar-dolomite. The permanent lining is of magnesite brick. Lining life varies from 50 to 85 heats.

In addition to mechanical equipment to provide for rotation, additional equipment is required to raise the vessel to facilitate charging of lime and sinter and for tapping. In operation, the converter mouth is positioned so that the fume is discharged into a water-jacketed hood. A water-cooled oxygen lance passes through the hood and is positioned to impinge at an acute angle on the slag surface. The angle of the oxygen lance can be altered to suit desired operating conditions. The oxygen tube in the water-cooled lance is 3 in. in diam. Lance life averages 700 heats.

With the converter in the operating position, oxygen is turned on and the converter is rotated at speeds up to 30 rpm. Rotation of the converter enables cooling of the refractory lining. The heat evolved from the combustion of the carbon monoxide above the bath heats the refractory and, as the vessel rotates, the molten slag-steel mixture covers the heated lining and cools it. If desired, the Kaldo converter can be rotated with-

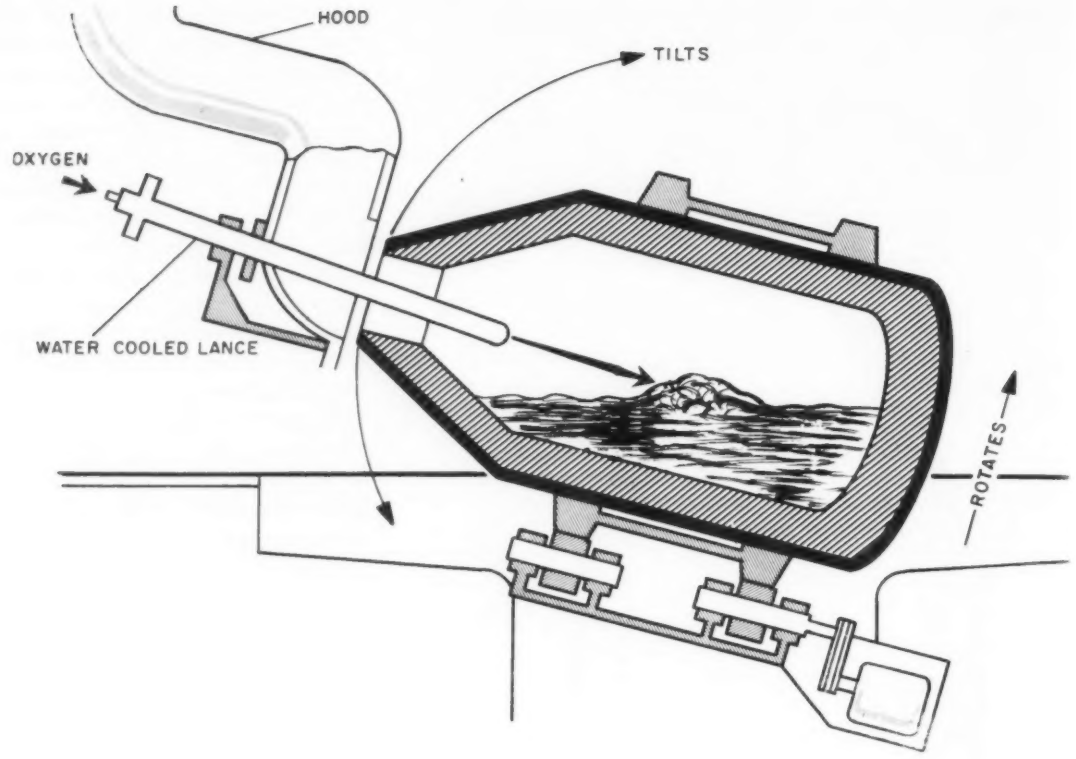


Figure 4 — Schematic shows Kaldo process.

out introducing oxygen. This rotation permits further control of the reaction rates during various stages in the heat.

Hot metal chemistry is not critical for the Kaldo converter. With American medium-phosphorous irons, a two-slag process is generally required. The lime-silica ratio of the first slag is adjusted to approximately 1.5 to 1. The rotational speed provides establishment of near equilibrium levels between the metal and the slag. Iron in this slag averages between 2 and 3 per cent. After slag-off, a new slag composition of lime and ore is added to complete the removal of phosphorous and sulphur. Iron with up to 0.300 per cent phosphorous can be processed to provide 0.015 per cent phosphorous in the steel with a single slag.

Ore or scrap can be used for cooling. Additional refractory damage is experienced if scrap is added to the converter vessel rather than ore. Using U. S. basic iron, about 40 per cent scrap can be consumed in the Kaldo converter. A greater amount of scrap can be melted in a Kaldo converter than in the LD process because a greater portion of the carbon monoxide which is evolved from the bath is burned to carbon dioxide with the evolution of additional heat.

Kaldo process is very flexible and both high and low carbon steels can be processed. The Kaldo process can produce a high carbon steel having a low phosphorous content since phosphorous reduction is obtained with carbon reduction. The steel sulphur content is controlled since the rotation provides for intimate mixing of the slag and steel. The oxygen content in Kaldo steel, as in all steelmaking processes, is controlled by the carbon-oxygen equilibrium relationship. The agitation provided by the rotation generally results in Kaldo steels having a somewhat lower oxygen content than open hearth grades for equivalent chemistry.

Nitrogen content in the steel can be minimized with the Kaldo process. Using 95 per cent purity oxygen, steel can be produced with between 0.002 and 0.003 per cent nitrogen. With higher purity oxygen, steels with lower nitrogen contents are possible. At Domnarvet during 1957, the oxygen supply averaged 95.3 per cent for 379 heats of 0.10 to 0.12 per cent carbon, 0.50 to 0.60 per cent manganese rimming steel, nitrogen in the steel averaged 0.0027 per cent. For 0.05 to 0.07 per cent carbon, 0.25 to 0.35 per cent manganese rimming steel, nitrogen content in the steel averaged 0.0026 per cent for 179 heats.

An assured oxygen supply system is extremely important for the Kaldo process since an interruption in oxygen supply results in a shutdown in steel production. The Kaldo converter uses relatively low pressure oxygen, about 45 psi. The metallurgical advantage of using low pressure oxygen is that the reaction is quiet and iron losses to the exhaust gases are reduced.

Rotor process—A third major steelmaking process developed in Oberhausen, Germany, is called the Rotor process.

A schematic diagram of this process is shown in Figure 5.

The Rotor process utilizes a horizontal, cylindrical, kiln-type vessel rotated about its longitudinal axis. Pilot-scale work was done on a 20-ton unit. The present 66-ton furnace is 12 ft OD, 9 ft ID and 48 ft long. Furnace is rotated between 0.5 and 2.0 rpm. The furnace has a working lining of tar-dolomite with a backing of magnesite. Openings are provided at each end of the rotor. The opening at the entry is for charging and introduction of the water-cooled lances. At the other end, another circular opening is provided for removal of the waste gases. Provision is made so that the rotor furnace can be tilted three feet at either end to facilitate charging and tapping and to control the carbon oxidation reaction. The tap-hole is located in the periphery of the discharge end. For tapping, the tap-hole is opened, the furnace is tilted and revolved

so that the tap-hole is below the molten steel surface.

The 66-ton rotor at Oberhausen produces steel with a tap-to-tap time of approximately two hours. The blowing period averages 50 to 60 min, charging hot metal, lime and ore requires 30 min and slag removal and tapping requires 10 min.

Oxygen is introduced through two water-cooled lances installed on a movable cart. To start blowing, the oxygen lances are introduced through the opening in the entry end of the rotor. One lance is positioned so that oxygen is injected below the molten steel surface and the second lance is positioned so that the oxygen is discharged above the molten steel surface. Using this lance arrangement, the oxygen injected below the molten steel surface oxidizes the carbon in the bath to form carbon monoxide which is then further oxidized to carbon dioxide by the oxygen introduced above the bath. With this technique excellent heat economy is attained in the rotor and up to 15 per cent iron ore has been utilized as a coolant. Considerable difficulty was experienced during the early experimentation to develop a suitable lance which would have adequate life when immersed below the molten surface. At present, the lances average 300 heats.

Oxygen supply is critical since an interruption in oxygen results in a curtailment of steel production. At least, 99 per cent purity oxygen is required for the lance which is immersed in the steel bath to eliminate the possibility of nitrogen pickup in the steel. The lance positioned above the bath uses 73 per cent purity oxygen.

The rotor can be used for prerefining of high phosphorous iron or in the direct production of steel. The process is suited for production of low, medium and high carbon steels.

Phosphorous can be controlled and phosphorous removal occurs early in the process, prior to complete carbon removal. Oxygen content in the steel is comparable to the best open hearth and electric furnace grades. For high phosphorous irons, a two-slag process is required.

COMPARISON OF STEELMAKING PROCESSES

Each of the steelmaking processes has relative advantages or unique features which influence production rate or provide metallurgical or economic benefits. Economic studies of steel processes are influenced by the degree of capitalization of existing equipment. General engineering comparisons of steelmaking processes can be made and are useful for proper orientation, however, a thorough evaluation must take local conditions into consideration.

Scope of processes— The open hearth produces a greater variety of steel compared to the LD, Kaldo and Rotor furnaces. The open hearth can make rimmed, killed, semikilled and low-alloy steels with equal flexibility. Most important, is that technology and costs are known and experienced operators are available.

The LD process, at the present time, cannot readily make as wide a variety of steels as the Kaldo or Rotor processes, particularly if the charge includes high phosphorous iron. The LD process is presently used to a limited extent to make high carbon and low-alloy steels.

Continued experimentation with the LD process will extend the scope so that this process can produce equally as wide a variety as the Rotor and Kaldo processes. Lime injection techniques can be utilized to control phosphorous and sulphur. Injection of ore and close control of lance height above the bath can aid in promoting the dephosphorization reaction. Success is already reported using two and three slag processes to control high phosphorous irons in the LD converter. Even with the incorporation of these process modifications, the LD process will produce steel at a greater rate than either the Kaldo or Rotor.

Cost of steel is dependent on a number of factors. Of considerable importance is the relative cost of scrap and hot metal. Thus the scrap melting ability of a process has a decided effect on total steel cost. In the United States there is considerable quantity of relatively low cost scrap available especially in periods of reduced steel demand.

The open hearth furnace is most flexible in its ability to operate with a wide variation in hot metal ratios, and therefore can take maximum advantage of fluctuations in metallic costs. The Rotor and Kaldo processes can melt more scrap than the LD process, however, the scrap melting ability of all these furnaces at the present time is decidedly less than the open hearth furnace.

Scrap melting capability of LD furnace may be increased in the future by new developments which utilize the heat presently lost in the exhaust gas. Also, controlled addition of readily oxidizable, heat-producing agents to the metal bath, such as carbon and

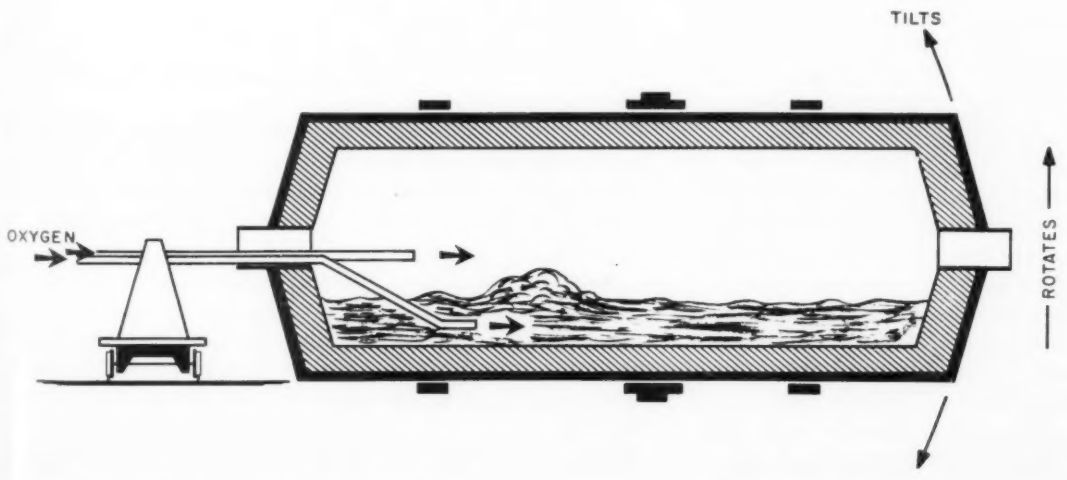


Figure 5 — Schematic shows Rotor process.

coke breeze, promise to increase the scrap-melting ability of LD converters. Our company is proposing the use of high velocity, high temperature, oxy-fuel flames through LD lances for melting greater quantities of scrap. Production-scale tests are expected to start as soon as the high capacity oxy-natural gas mixer is proved in open hearth tests presently underway.

Nitrogen content in steel averages about 0.004 per cent in the open hearth. All three oxygen processes produce steels with comparable or lower nitrogen content. The Kaldo process produces a lower nitrogen steel than the LD or Rotor using similar oxygen purities. The reason for this is that the oxygen stream impinges at an angle onto the slag and steel surface in the Kaldo whereas the oxygen stream penetrates the steel in the LD and Rotor processes.

In the Kaldo process the oxygen reaction is primarily slag-steel. Since reaction rates with oxygen are very rapid, the nitrogen impurity in the oxygen is released quicky, probably very near the surface of the bath and diluted by the carbon monoxide which issues from the bath. Thus in the Kaldo, the nitrogen has little time in which to be dissolved in or react with steel.

On the other hand in the LD and Rotor which are penetration processes, the nitrogen impurity penetrates the steel to a greater depth with the oxygen jet. Again the oxygen reaction rates are very rapid and the nitrogen bubbles remain in contact with the steel and effect a partial pressure during the period the bubbles are rising to the surface. The nitrogen content in the steel is a function of the partial pressure of these nitrogen bubbles. Also greater nitrogen atmosphere to steel surface contact area, longer time in contact with the steel and higher, localized temperature, all enhance nitrogen pickup in steel in penetration processes.

At present, the Kaldo and Rotor processes are more suited than the LD for the production of steel from medium phosphorous iron, especially high carbon grades. This condition would be found in Southern United States. Again in this particular case, it would be advisable to make experimental heats prior to selecting the Kaldo or rotor in perference to the LD.

Simplicity of furnace operation—Open hearth process is relatively complicated and can still be considered an art rather than a science. There is sufficient trained manpower however, so that open hearth operation is readily controlled.

LD process is simplest of the three oxygen processes from the standpoint of ease of operation, especially for the production of low carbon steels where tap carbon can be determined by the "drop in the flame" or by a time cycle. In fact, for low carbon steels produced with low phosphorous hot metal, the LD process can be considered the first true "push-button" steelmaking technique.

Compared to the LD, Kaldo and Rotor furnace crews require a greater understanding of steel technology. The rotational features provided by both the Kaldo and Rotor are metallurgically and technically sound. Considering the conditions in the United States, there is some question, however, as to whether the metallurgical benefits of furnace rotation would balance the attendant mechanical and refractory complications.

Speed of processing—The open hearth with accelerated charging, roof lances and improved combustion can probably average about 60 tons per hr in the near future. The LD process is inherently more rapid than the Kaldo, Rotor and open hearth. At present, the LD process can average over 100 tons per hr tap-to-tap. Initial oxygen flow rates for LD vessels averaged about 2000 cfm. Present oxygen flow rates are about 6500 cfm and under consideration are oxygen flow rates of 10,000 cfm and greater. At 10,000 cfm and U. S. irons, LD converter could produce in the range of 360 tons of steel per blowing hour. Considering all factors, even this rate may not be the technical limit.

Present large-size LD vessels have about a 90-ton capacity. Under consideration in the U. S. are LD vessels up to 300-ton capacity. There is some question whether LD vessels over 150 tons are economically attractive when considering the necessity for more expensive auxiliaries.

Kaldo and rotor process would be limited with respect to a maximum steel production rate below that of LD capabilities because of mechanical, refractory and blowing limitations. The rotor probably can introduce more oxygen with less damage than the Kaldo because immersion blowing minimizes slag and metal splash. Since steel production rate has a direct relationship to oxygen blowing rate, the highest steel production can be expected from the LD, followed by the Rotor and Kaldo.

The direction and quantity of metal and slag splash depends on the angle at which the oxygen strikes the bath. When an oxygen jet strikes perpendicular to a steel bath, the splash erupts from the bath essentially perpendicularly. If an oxygen jet strike the bath at an acute angle, the splash of slag and metal is fan-shaped and sprays from the bath at essentially a "reflection angle" of the oxygen impingement angle. In the LD, the oxygen strikes perpendicular to the bath and considerable quantities of oxygen can be injected since only a small fraction of the violent slag and metal splash will impinge on the sidewalls of the refractory vessel. The vertical component of the splash has minimum detrimental effect since there is no roof on the LD vessel. On the other hand in the Kaldo and rotor vessel, the maximum rate of oxygen introduction will be reached when the splash causes excessive wear of refractory linings. The design of these converters is such that the splash will impinge on the refractory walls. Of course future developments may modify this limitation by use of multiple lances or multiple orifices in single lances.

Equipment and refractory—The major advantage of the open hearth furnace is that the equipment is well known and trained operators are available for construction and rebuilds.

The LD converter is inherently simpler in design and maintenance than either the Kaldo or Rotor furnace because no equipment is required to provide for rotation. The LD converter is also lower in weight for equivalent steel capacity.

Fume disposal and cleaning systems are simpler for the Kaldo than for the LD. Exhaust gas temperature of the LD is higher. The dust loading from a Kaldo vessel is about 25 per cent less than the dust loading from an LD. The fume particle size is primarily under one micron for the LD and over one micron for the Kaldo. Both water washing and electrostatic precipita-

tors are proving fairly effective for cleaning.

Refractory consumption is an important consideration in the cost of steel production—not only considering initial cost but cost of installation. Open hearth refractory consumption averages approximately 75 lb per ton of steel. The LD process requires between 17 and 25 lb of refractory per ton of steel of which up to 20 per cent can be reclaimed. These refractory consumptions have been confirmed in large-size production installations by several LD converter operators.

Since there are no large Kaldo units in operation, no information is available on refractory consumption. Estimates are generally projected on the basis of experience on the 30-ton unit presently in use. In one estimate, the Kaldo process reported a refractory consumption of 77 lb per ton of steel of which 40 per cent could be reclaimed if a medium carbon steel were produced from 0.60 per cent phosphorous hot metal. In another case, refractory consumption was estimated at 45 lb per ton of steel. One U. S. concern conservatively estimated a refractory consumption of 30 lb of magnesite per ton of steel for the Kaldo process in producing a 1.30 per cent carbon, 0.015 per cent max phosphorous steel from a 3.8 per cent carbon, 0.250 per cent phosphorous iron.

Refractory consumption with the Rotor process averages 110 lb per ton of steel but further experience is expected to reduce this to below 75 lb per ton of steel. With experience it can be expected that the Rotor will show refractory consumption comparable to the Kaldo but greater than the LD.

No doubt experience will result in a reduction in refractory consumption for the Kaldo and rotor, however, it is safe to assume that at best these processes will approach only the refractory consumption of the LD unit and not improve on it. At the same time, it can be expected that refractory consumption of LD vessels will be reduced by further experience, better refractories and by improved charging and patching techniques.

Open hearth rebuilds are required after approximately 130 heats with silica roofs and after about 400 to 500 heats with a basic roof. Lining life varies between 150 and 500 heats in the LD vessel, up to 85 heats for the Kaldo and between 40 and 60 heats for the Rotor. Thus the LD process shows a much longer lining life than the Kaldo or Rotor, and in addition, relining time is shorter for the LD vessel.

Yield—Steel mill yield varies with the type of furnacing equipment and with conditions existing in the individual mill. Steel mill yield will also depend upon how closely equilibrium is reached between the slag and metal phases, eliminating consideration of spitting and slopping. Equilibrium in chemical reactions is influenced to a great extent by agitation. Thus, it can be expected that yield will vary for steelmaking processes depending upon the mixing of the slag and metal. From this, it can be expected that highest yield would be obtained with the Kaldo process, followed by the Rotor, LD and open hearth, in that order. Of course if it becomes economically necessary to improve yield in LD vessels, mechanical equipment can be considered to provide slag-metal agitation. Using medium phosphorous irons, one mill reported a yield of 88.6 per cent for the LD and about 89.2 per cent for the Kaldo process under similar conditions. In another program, using similar medium phosphorous irons and producing low carbon steels, ingot yield for the Kaldo process was between one and four per cent greater, depending on product chemistry. With care and proper operation, each of the oxygen steelmaking processes should show better yield than an open hearth furnace under similar conditions.

Oxygen—Oxygen usage in the open hearth depends upon the availability of oxygen and the desired steel production rate. In usual practice, roof lances require between 450 and 700 cu ft of oxygen per ton of steel.

The LD, Kaldo and Rotor processes consume more oxygen than the open hearth. For equivalent iron chemistry, the Rotor and Kaldo processes will consume more oxygen than the LD technique because additional oxygen is used to burn the carbon monoxide to carbon dioxide above the bath. Typical values for producing low carbon steel from iron with about 0.70 per cent phosphorous indicate that the LD process would consume 1945 cu ft per ton of steel, the Kaldo, 2300 cu ft per ton of steel, and the rotor, 2480 cu ft per ton of steel. In U. S. practice, oxygen consumption will average about 1700 cu ft per ton of steel for the LD process. Generally oxygen consumption will be about 10 per cent higher with the Kaldo and rotor processes.

High purity oxygen is required for the Rotor and LD processes. Use of oxygen containing nitrogen will be reflected in a nitrogen pickup in the steel. In fact, the nitrogen content in the steel will be directly proportional to the nitrogen content in the oxygen gas for penetration blowing processes such as the LD and rotor. For the LD and rotor it is generally desired to use oxygen of 99.5 per cent purity. The oxygen used in the lance which is positioned above the bath in the rotor process does not require high purity since only a combustion reaction is taking place.

The open hearth and Kaldo processes do not require high purity oxygen. In the Kaldo process, open hearth quality steels can be made using 95 per cent purity oxygen.

Cost of producing oxygen is not significantly affected by oxygen purity. The savings obtained by producing low purity oxygen would depend upon the relative costs of labor and services and the size of the plant. In an economic evaluation of low purity oxygen processes, consideration must be given to the additional costs incurred by the requirement of a separate system for high purity oxygen supply and piping to provide for those applications requiring high purity oxygen, such as scarfing and cutting. Generally, only a high purity oxygen system is recommended.

The Kaldo process presently utilizes lower pressure oxygen than the open hearth, LD or rotor. Oxygen costs are reduced with reduced pressure requirements. Again, an economic study would have to be conducted by the individual steel mill to determine optimum pressure for over-all oxygen system, including pipelines and storage. Technically, the LD, rotor and open hearth processes can use lower pressure oxygen than presently used. Experimental heats have been made in LD vessels with oxygen pressures of 60 psi. If desired, further study would be required to determine the lowest usable pressure for the LD process.

In most instances the optimum oxygen system incor-

porates an oxygen plant with a 400 to 600-psi storage bank and subsequent regulation to provide for 180 to 200-psi oxygen at the point of use. Open hearth pipelines are generally at 130 psi. Gaseous storage bank capacity must be adequately designed to provide uniform oxygen supply during the severe "on-off" type service inherent to the oxygen steelmaking processes. For maximum reliability, two one-half size oxygen plants, proper gas storage capacity and adequate liquid oxygen generation and storage is desirable to maintain steel production in case of scheduled or unscheduled shut down of the oxygen plant.

Oxygen supply is not as critical for open hearths as it is for LD, Kaldo and Rotor processes. Open hearths can operate, though less efficiently, if the oxygen supply is interrupted by reverting to ore practice until the oxygen plant is onstream.

FUTURE

Choice of melting equipment for increasing capacity in an existing steel plant or the construction of new capacity depends upon many factors. Among these are the condition of the existing melting and handling equipment, the extent to which existing equipment is capitalized, the availability and cost of scrap and hot metal and chemistry of the raw materials and product specifications. Thus, as is evidenced in announced plans, steel expansion can be affected by expanded use of oxygen in open hearths and installation of LD, Kaldo and rotor processes or a combination of these processes.

The open hearth furnace will remain the dominant steelmaking furnace in this country for the next five years. The main reason is that open hearths are built. Total open hearth steel capacity in 1965 will probably be less than in 1959. The tonnage decline will be nominal because any economic study of open hearths will be favored by reduced capitalization costs, by increased steel production rates because of new developments and by the inherently-greater scrap-melting ability of the open hearth.

Steel mills having relatively modern high-capacity open hearths will increase capacity from these units by expanded use of oxygen for flame enrichment and roof lances. The LD, Kaldo and rotor will be given preference over the open hearth in wholly new construction and in those steel plants replacing old, less efficient open hearth furnaces.

By 1965, it can be expected that almost every basic open hearth in operation will be equipped to utilize major amounts of oxygen for refining and combustion. It is extremely doubtful that new open hearth construction will be undertaken.

On the contrary, indications are that existing open hearths will be shut down and output markedly increased from the remaining furnaces by expansion in oxygen uses in roof lances and combustion. This trend is presently underway since several steel mills are evaluating the economics of shutting down furnaces and maintaining the same output from a lesser number of oxygen-equipped furnaces.

Experimentation presently underway on increased use of oxygen for roof lances and combustion promises to further increase the production rate of open hearths over present levels. One technique under study is to increase oxygen flow rates into open hearths through roof lances to decrease the elapsed time from "end of hot metal-to-tap." Figure 6 shows carbon drop on two heats: one in which oxygen flow was maintained at 25,00 cfhr throughout the heat and one in which oxygen flow rate through roof lances was increased from 25,000 to 45,000 cfhr when the bath carbon reached about 0.45 per cent. This increase in oxygen flow rate

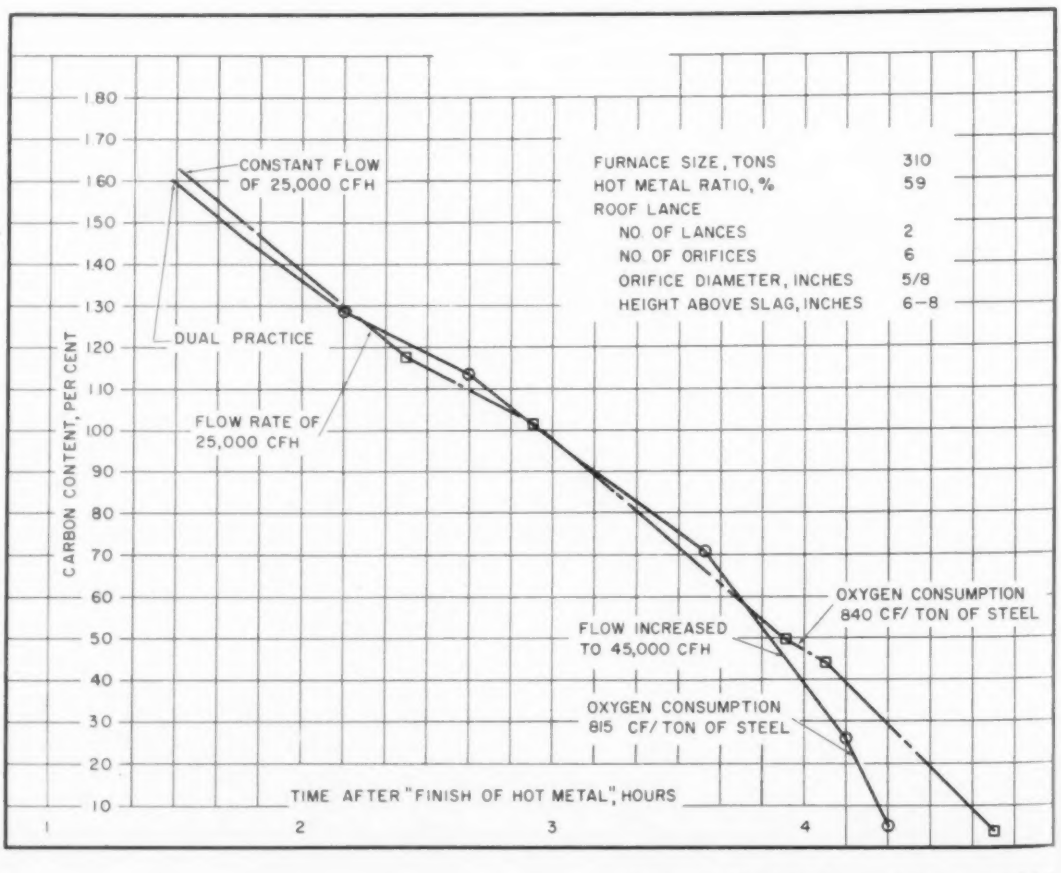


Figure 6 — Graph shows carbon reduction attained with constant and "dual practice" oxygen flow rates.

near the last stages of refining shows no adverse effect on roof life since carbon evolution and metal splash are markedly reduced when the bath carbon is below 0.45 per cent. Control tests with this "dual practice" oxygen addition increased tons per hour 4.2 per cent over standard practice while the oxygen consumption per ton of steel remained constant.

A more recent development which promises to have a greater impact on open hearth steelmaking is the direct combustion of fuels with oxygen. Tests are underway in which oxygen and natural gas are burned through open hearth roof lances. Scrap meltdown rates are markedly accelerated. Figure 7 shows a six-orifice open hearth roof lance designed for 25,000,000 Btu's per hour. Flame temperatures produced by this unit are about 5000 F. As desired, the natural gas can be shut off and this lance can be used with oxygen alone.

Figure 8 shows the flame from an experimental burner. This flame is about 56 in. long and is equivalent to one of the flames in the 6-orifice roof lance. Work on the program is presently underway on methods to eliminate burner flashbacks and on techniques to improve the flame area-furnace hearth area ratio. Of course, decided improvements will have to be effected in present open hearth charging techniques to benefit from these developments.

In summary, the LD process produces low-nitrogen, high quality steel at low cost and at high production levels from a wide variety of irons. The process is extremely well suited to the production of low carbon steels. In the United States, medium carbon steels have been produced successfully. Recently, successful production of low-alloy steels have been reported from Austria. Today, approximately 20,000,000 tons of steel in the world are produced by the LD process with 4,000,000 tons in the United States.

Indications are that at least 20 per cent of steel capacity in the United States will be produced in LD vessels by 1965. Expansion of the LD process has proceeded at a much greater rate outside of the United States.

Considering all the inherent advantages of the LD process and its relative infancy, continued experimentation and production experience will result in the wider application of this process. It can be expected, therefore, that in the future, the LD process will contribute the major portion of new steel melting facilities.

The Kaldo process is a relatively simple, high production steelmaking unit with the inherent advantages of flexibility of operation, control of product chemistry and good thermal efficiency. Drawbacks are the need for additional mechanical equipment, higher refractory consumption and need for more skilled labor. The Kaldo process is expanding and three 110-ton units are scheduled at Sollac in France, two 110-ton units at Oxelosund, Sweden, and two 110-ton units at Domnarvet, Sweden. Also, early in 1960, another Kaldo installation will begin in Europe.

Expansion in the Kaldo process will be limited primarily to those areas having medium and high phosphorous iron and where the product mix requires a relatively high percentage of medium and high carbon steels. Even in these areas, the expansion of the Kaldo process will be considerably limited as further experience is gained and improvements are developed to widen the

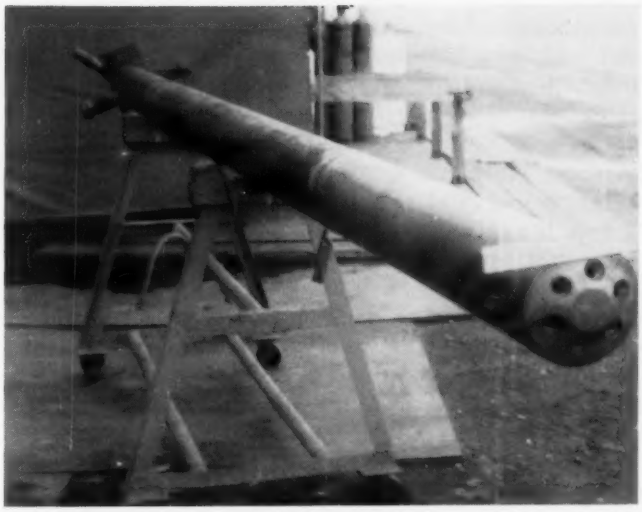


Figure 7 — This six-orifice open hearth roof lance is designed for 25,000,000 Btu per hr.

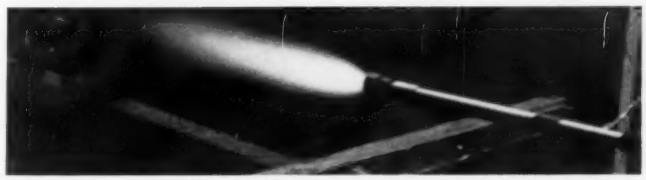


Figure 8 — Experimental burner with flame approximately 56 in. long is equivalent to one of the flames in the 6-orifice roof lance.

scope of LD processing. Nationalistic considerations will have an influence on some of the expansion plans.

An interesting development is that a steel company in Europe is considering the installation of a combined LD-Kaldo furnace shop. This will be a new construction and present plans are for starting operation in late 1961. In this case, the shop will install two 100-ton Kaldo and two 100-ton LD vessels, only one of each vessel operating at one time. Weight of the Kaldo vessel, including lining, will be 420 tons. The LD vessel will weigh about 200 tons. The Kaldo will have four 65-hp motors for rotation. Refractory consumption is estimated at about 60 lb per net ton for the Kaldo and about 13 lb per net ton for the LD. The hot metal in this steel mill is: carbon, 4.0 per cent; silicon, 0.8 to 1.2 per cent; phosphorous, 0.6 to 0.8 per cent; manganese, 0.75 to 0.90 per cent; and sulphur below 0.06 per cent. Steel sulphur specifications will be 0.03 per cent max and phosphorous 0.03 per cent max. Present plans are to use the Kaldo process to produce steel with a carbon range from 0.25 to 0.80 per cent. The LD vessels will produce steel with carbon specifications below 0.25 per cent. There will be two slaggings on the Kaldo heats and three slaggings on the LD heats. The additional slagging on the LD heats is required because a lower carbon steel will be produced. Slag weight will be 14 per cent on the Kaldo and 16.5 per cent on the LD. The finishing slag from the previous heat will be the starting slag on the next heat for the Kaldo. This practice will not be used on the LD. Tap-to-tap time on the LD heats will be about 70 and on the Kaldo heats about 105 min. Oxygen purity will be 99.5 per cent for both processes. Of major interest is that this shop is designed so that only the Kaldo vessels need to be removed to convert to LD when a positive method is developed for producing high carbon steel

from medium phosphorous iron. This mill will experiment with lime blowing in the LD vessels to control phosphorous.

The Rotor process has proved successful from a technical, metallurgical and economic standpoint. Operating costs are less than the open hearth. At Oberhausen, a 110-ton rotor has been installed to supplement the output from the experimental production 66-ton unit. In addition, two 110-ton units are scheduled in Peine, Germany, and four 110-ton units at Iscor, South Africa. A rotor furnace for the pretreatment of iron will be installed in a steel mill in England. Rotor process will find limited application, primarily in countries outside of the United States. Again, nationalistic considerations will have an influence on expansion.

The relative expansion of any of the above processes can be markedly accelerated if a technique is developed which will substantially improve steel quality. This is highly possible considering the intensive research programs presently underway. Royalty structure can also have an influence on the expansion of the steelmaking processes.

Discussion

PRESENTED BY

D. R. BERG, New Product & Process Development, Machinery Div., Dravo Corp., Pittsburgh, Pa.

E. F. KURZINSKI, Manager, Applied Research and Development, Air Products, Inc. Allentown, Pa.

D. R. Berg: The following comments are limited to statements made by the author relative to the Kaldo oxygen steelmaking process.

The vessel presently in use at Domnarvet, Sweden, has a process time of 80 min. This process time applies for normal production at this plant when using a pig iron with the following composition: 3.75 per cent carbon, 0.30 per cent silicon, 0.60 per cent manganese, 1.85 per cent phosphorus and 0.05 per cent sulphur, at a charge temperature of 2250 F with a coolant consisting of sinter fines. Of the 80-min process time, 40 min consist of blowing time and 40 min of nonblowing time. With test heats consisting of a hot metal composition of 4.3 per cent carbon, 0.75 per cent silicon, 1.5 per cent manganese, 0.11 per cent phosphorus and 0.05 per cent sulphur, at a charge temperature of 2200 F and with scrap as the coolant, the processing time has been 67 min, of which 27 min have been blowing time and 40 min nonblowing time. Physical limitations in the plant as built are being corrected to permit a blowing time of 19 min with the low phosphorus pig iron and scrap charges. The nonblowing time is in excess of that projected for plants incorporating adequate support facilities. New plants are designed for production rates (tap-to-tap time) in excess of 100 tons per hr per furnace when producing 110-ton heats from a charge consisting of low or medium phosphorus pig iron and scrap.

Lining life at Domnarvet in the 30-ton furnace with 16 in. thick tar-bonded brick and with a high phosphorus pig iron and a sinter coolant has averaged 70 heats for the past several months. The result of recent developmental work with linings at Domnarvet gives complete assurance of an average of 100 heats per lining there. A well known American refractory company which has participated in much of the lining development work at Domnarvet over the past 20 months predicts lining life in the 175 to 200 heat range for 100-ton and larger furnaces operating under American steelmaking conditions.

Lance life at Domnarvet is in excess of 1000 heats.

With American medium phosphorus irons, a two-slag process is not generally required. Production of approximately 100 test heats at Domnarvet using such iron has shown a one-slag technique to be suitable.

As a result of over 100 heats produced at Domnarvet with scrap as the coolant, it has been determined that refractory life is approximately the same as when using sinter or ore as the coolant.

Using United States basic iron, scrap in the 45 to 50 per cent range can be consumed depending specifically upon hot metal chemistry, the hot metal temperature and blown metal chemistry. In addition to the reason for this scrap melting capability described in the paper, there is another and equally important reason. The rotational characteristic of the furnace provides a good heat exchange medium. During rotation, when the refractory is in the void above the metal bath, it absorbs heat created by combustion of gases in the void and then, when it rotates under the bath, it gives up the heat to the bath. Furthermore, the radiation from the refractory above the void is directly into the bath.

The oxygen blowing rate with the Kaldo process will increase sharply with the construction of plants with furnaces which are larger than those in Domnarvet and of more efficient configuration. For furnaces of approximately 100 tons in size now being constructed or designed, oxygen flow rates in excess of 6000 cfm will be used initially. Little is known today regarding the technical limit of oxygen flow rates with this process. The operation of several plants with 100-ton and larger furnaces will result in exploration of this factor.

The extent to which slag will be splashed on the refractory of the Kaldo furnace with larger furnaces than the one now in operation at Domnarvet cannot be predicted definitively but lances presently being tested at Domnarvet indicate a minimized effect of slag splash at elevated blowing rates.

In addition to the facts pertinent to the size and volume of the solids in the gases emitting from the Kaldo furnace mentioned by the author, total gas volume, an important factor in the design of gas cleaning systems, is low. Because of the high rate of conversion of CO to CO_2 inside the furnace, a nominal amount of atmospheric air is inspirated at the furnace mouth to complete combustion of the carbon monoxide. This keeps to a minimum the volume of the gases that must be cleaned beyond the volume emitting from the furnace.

Refractory consumption per ton of ingot with the 30-ton furnace at Domnarvet has declined steadily over the past two years from 75 to 50 lb with the immediate prospect of 35 lb. With furnaces in the 100-ton heat size range, less than 20 lb of refractory per ton of steel will be used. The predictions of the American refractory manufacturer most familiar with the Kaldo process indicate refractory consumption of less than

15 lb per ton of ingot.

The relining of a Kaldo furnace is facilitated by the removable bottom. This permits rapid cooling and efficient material flow both for the removal of residual working lining and installation of new working lining material. Based on actual performance at Domnarvet in the 30-ton furnace, the total time required for furnaces in the range of 100 tons between completion of the final heat on one lining and charging the first heat on the subsequent lining is scheduled for 60 hr.

With respect to yield, the agitation of the slag and metal provided by the rotation of the Kaldo furnace produces a condition approaching equilibrium of iron oxide in slag and carbon in the bath. Of additional importance is the minimizing of iron loses in exhaust gas resulting from lack of direct impingement of oxygen on metal and the consequently low quantity of vaporized iron. These two inherent characteristics of the Kaldo process contribute significantly to the production of more steel per unit of charge, a factor which is of considerable importance to steel producers.

Continuing developmental work with the 30-ton unit at Domnarvet, Sweden, constantly produces information regarding the technical and economic capabilities of the Kaldo process. The operation of two plants in Europe with 110-net ton furnaces which will start in 1960 will be a source of further information regarding the process. These and other plants scheduled for operation after 1960 are expected to contribute to a more rapid rate of development of the process than has been the case with only one plant with a small furnace in production. Based on presently known facts, application to a broad variety of steelmaking conditions throughout the world is practical. Operation of additional plants under varying conditions will serve to broaden the already broad application suitability.

E. F. Kurzinski: The author, in discussions with personnel at IRSID, had been advised that there is only a minimum of experience with use of low and medium phosphorous irons. The reason for the lack of information on these irons is that primary interest in France is on developing techniques for processing irons with phosphorous contents in excess of 1.00 per cent. IRSID thinking at present, though, is that there will be no difference in steel yield whether lime is added by a bulk addition or a fluidized addition as practiced in the OLP process with iron phosphorous below about 0.40 per cent.

Referring to the comments of Mr. D. Berg, as explained in the paper, the information presented was the result of discussions with steelmakers, consulting engineers and refractory producers of North America, Asia and Europe—of study of reports of tests at Sweden and Austria, production records of LD installations, installation drawings of oxygen steelmaking facilities and predictions of steel companies planning installation of LD, Kaldo and Rotor vessels—and of observations of LD, Kaldo and Rotor installations. Purpose of this paper was to take all of this available data and present what was in the author's judgment, a fair evaluation of the present status of processes without regard to having to promote any particular process. In a subject as broad and as complex as this is, it can be expected that open hearth, LD, Kaldo or Rotor people can present test or limited production data which will be more favorable to their processes.

With respect to refractory consumption, the author had access to a report which predicted a refractory consumption of 15 lb per ton of steel for the Kaldo. It did not seem right to include this refractory consumption in the paper since it is in the realm of conjecture. The author did say that the Kaldo and Rotor will have lower refractory consumptions in the future. The conclusion, though, was that the LD always will have a lower refractory consumption than the Kaldo—which conclusion the author believes is logical.

In this respect, Kaiser Engineers also advised by letter that it was their opinion that the "17 to 25 lb of refractory per ton of steel for the LD" was high. Again, the author had production data which showed furnace campaigns with refractory consumption below 15 lb per ton of steel for the LD. This lower consumption was not considered representative of over-all production experience and therefore was not included in the paper.

It is difficult to comment on the potential steel production rates of the various oxygen steelmaking processes. It seems though that projected steel production rates for the Kaldo increase in about a direct proportion to the actual production experiences of the LD.

The author agrees that insufficient is known today on the technical limit of oxygen flow rates in the Kaldo. This is also true of the LD, Rotor and open hearth. The conclusions drawn on the relative effect of oxygen flow rates, oxygen impingement angles and refractory damage are based upon considerable experience gained with operation of oxygen lances under a wide range of conditions in steelmaking furnaces.

Other advantages of the Kaldo, such as the minimization of iron losses in the fume and heat exchange between lining and slag-metal are covered in the paper.

The author would like to contribute the additional thought that where a rotational steelmaking process is being considered, the Rotor should be carefully studied. In the Rotor, the mechanical problems caused by vessel rotation are minimized since the vessel axis is horizontal. Use of two lances permits control of the carbon-oxygen reaction to a greater degree than in the LD or Kaldo as presently practiced. Only in the Rotor can the combustion of CO to CO_2 above the bath be minimized or intensified by controlling oxygen input to the upper lance. In the Rotor, major refractory damage occurs generally in the area of the oxygen lances. Thus refractory life can be essentially doubled in the Rotor by designing a vessel which can be turned around so that the lances may be inserted into what was originally the tapping side. Also vessel rotational speed can be increased if further agitation is proved necessary to improve yield or refractory cooling. A Rotor incorporating most of these features will be installed in Europe.

In summary, the conclusions in this paper are based on present practices; future developments or major changes in oxygen steelmaking practices may alter these conclusions. It seems however, that promotors of LD, Kaldo and Rotor vessels should more carefully consider and incorporate the best features of each of these processes to evolve the optimum oxygen steelmaking processes. ▲

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 28, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"13-Ft Wire Mesh Facilities at Gadsden," by C. J. Kinsey, Assistant Chief Engineer, Republic Steel Corp., Gadsden, Ala.

Hotel Reich, Gadsden, Ala.

BUFFALO SECTION

Tuesday, March 8, 1960—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Investigation of Factors Affecting Gage and Shape on a Hot Strip Mill," by Norman Wells, Section Head-Application, Special Controls and Drives, Electrical Dept., and John S. Ride, Metallurgist, Development and Special Duties Div., Metallurgical Dept., The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

Sheraton Hotel, 715 Delaware Avenue, Buffalo, N. Y.

CANTON SECTION

Monday, March 21, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Future Water Supply for the Canton Area." Speaker to be announced.

Mergus Restaurant, Canton, Ohio

CHICAGO SECTION

Tuesday, March 1, 1960—Dinner 6:15 P.M., Meeting 7:45 P.M.

"Gear Type Spindle Couplings for Steel Mill Drives," by Fred Paddon, Manager of Engineering and Sales, Amerigear-Bliss Spindles, Rolling Mill Div., E. W. Bliss Co., Salem, Ohio

"Gear Type Spindle Couplings for Steel Mill Drives," by P. Hollingworth, Chief Engineer Coupling Dept., Metal Products Div., Koppers Co., Baltimore, Md.

Phil Smidt's Restaurant, 1205 North Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 22, 1960—Social Hour 6:00 P.M., Dinner 6:30 P.M., Meeting 7:45 P.M.

Ladies Night

"Investing Is Part of Your Life," by Miss Erma H. Bender, Vice President, Joseph, Mellon, & Miller, Inc., Cleveland, Ohio

Movie: Manufacture of Tubes in Germany

Cleveland Engineering & Scientific Center, 3100 Chester Avenue, Cleveland, Ohio

COLORADO SECTION

Tuesday, March 15, 1960—Social Hour 6:30 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Wire Mill Operations," by C. C. Tappero, Superintendent, Wire Mill, The Colorado Fuel and Iron Corp., Pueblo, Colo.

Minnequa University Club, Pueblo, Colo.

DETROIT SECTION

Tuesday, March 8, 1960—Dinner 6:30 P.M., Meeting 8:00 P.M.

"Performance Characteristics of a Rectifier Powered Plate Mill," by J. E. Peebles, Steel Mill Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

"Rectifiers on Processing and Auxiliary Equipment," by A. S. Urano, Steel Mill Application Engineer, Metal Rolling & Processing Engineering, Industrial Engineering Div., General Electric Co., Schenectady, N. Y.

"Is the Fault Always Electrical?" by R. J. Byrnes, Senior Electrical Engineer, Cutler-Hammer Inc., Milwaukee, Wis.

Horace Rackham Educational Memorial Building Dinner and Meeting, Parlors E, F and G, Detroit, Mich.

LOS ANGELES SECTION

No March Meeting.

PHILADELPHIA SECTION

Saturday, March 5, 1960—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Oxygen Lance Open Hearth Practice," by W. E. Brandt, Assistant Division Superintendent, Open Hearth Div., Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"The Basic Roof for Open Hearth Furnaces," by K. D. Bartels, Superintendent of Masonry, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Design and Operation of Open Hearth Precipitators with Oxygen Lances," by A. T. Paradis, General Foreman Assigned Maintenance Open Hearth, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

Engineers Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 14, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Control of Alloy Carry-Over in Melting," by K. M. Shupe, Supervising Quality Engineer, and P. DuFresne, Quality Engineer, Latrobe Steel Co., Latrobe, Pa.

"Induction Heating of Alloy Steels for Rolling," by Roy H. Neer, Works Engineer, Latrobe Steel Co., Latrobe, Pa.

University Club, University Place, Pittsburgh, Pa.

ST. LOUIS SECTION

Wednesday, March 30, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Advanced Electrical Systems for Metal Rolling Mills and Processing Lines," by W. H. Dauberman, Sponsor Engineer, Steel Mill & Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

Elks Club, Granite City, Ill.

SAN FRANCISCO SECTION

Tuesday, March 15, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Judson Steel Corp. Night

"Symposium on Air Pollution Control in the Steel Industry," Moderator and Panel Members to be announced.

Shattuck Hotel, Shattuck & Allston Way, Berkeley, Calif.

UTAH SECTION

Monday, March 14, 1960—Social Hour 6:30 P.M., Dinner 7:30 P.M., Meeting 8:30 P.M.

"Modern Blast Furnace Practice," by L. Tofft, Division Superintendent of Blast Furnaces, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

Grandview Cafe, Provo, Utah

YOUNGSTOWN SECTION

Monday, March 28, 1960—Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"Direct Reduction of Iron Ore—Proposed Methods and Commercial Prospects," by Donald E. Babcock, Research Technical Consultant, Metallurgical Dept., Republic Steel Corp., Cleveland, Ohio.

Mahoning Country Club, Girard, Ohio

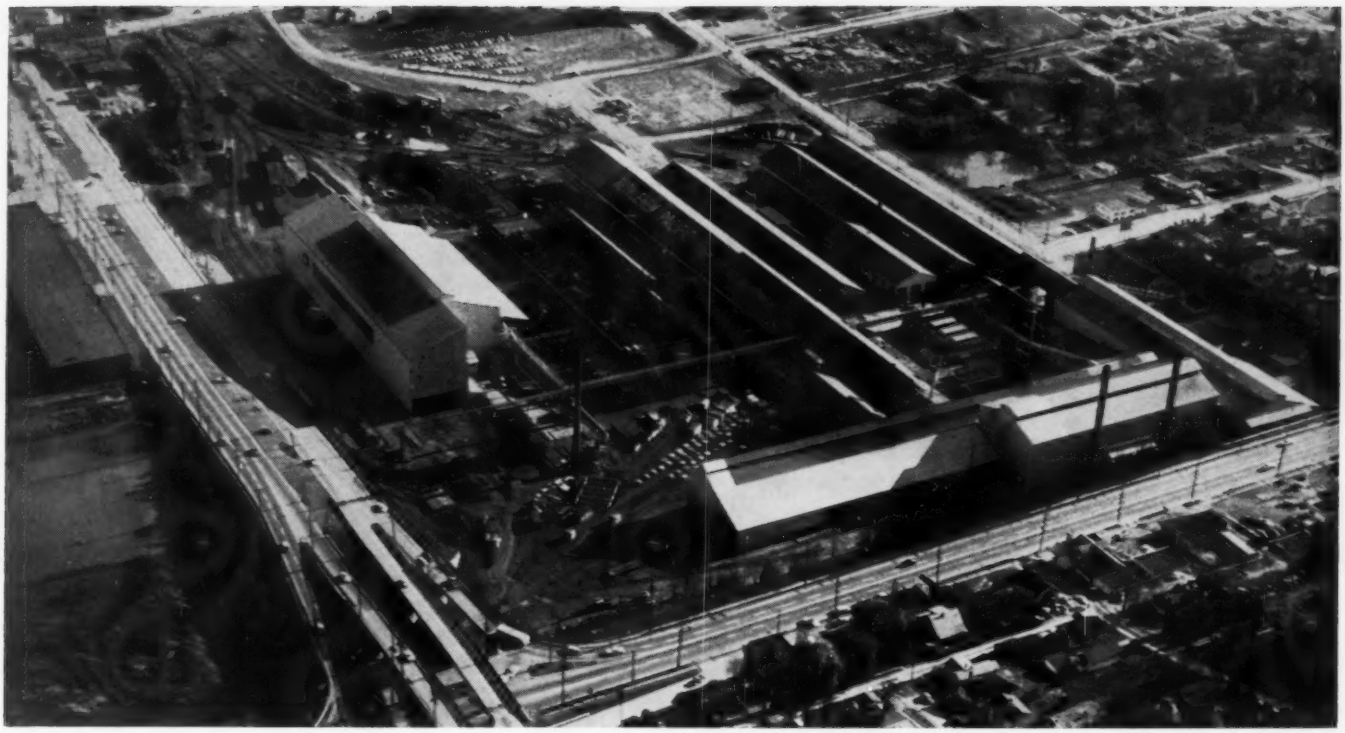


Figure 1 — The Seattle plant is hemmed in by urban development.

. . . . an extensive construction program at the Seattle plant of Bethlehem Steel increased tonnage capacity and provided means for producing quality steel . . . .

by N. L. BOCK, Chief Engineer, and KENNETH GRANT, Electric Furnace Superintendent,
Seattle Plant, Pacific Coast Div., Bethlehem Steel Co., Seattle, Wash.

Modernization of the Seattle Plant

INITIAL operation of a new merchant bar mill in Bethlehem Pacific's Seattle plant on January 5, 1959, virtually completed a major modernization program, the engineering of which had begun exactly two years previously with actual construction commencing a few months later. Because the changes involved, to a large degree, replacement of certain major production facilities in their entirety rather than expanding or improving them, the scope of this program was more extensive than the term "modernization" implies.

The Seattle plant (Figure 1) serves the Northwest and parts of Canada. Compared with many other areas throughout this country, the Northwest has not been a large consumer of steel; even today its demand for this commodity is modest by Eastern and Midwestern standards. It is apparent that any expansion of the steel facilities is directly related to the development and growth of the Northwest. Seattle, of itself, is not the Northwest but perhaps it can be considered as representative of that vast area.

Historically, Seattle had its inception in 1852 with the landing of five families on the shores of Puget Sound at what is now known as Alki Point. The Alaska gold rush 45 years later, and the opening of the Panama Canal in 1915, followed by shipbuilding activity during World War I stimulated the growth of the Northwest, and by 1920 Seattle had a population of 315,000. As in many other West Coast areas, military activities associated with World War II created a continuing interest in the Northwest so that now the population of Seattle has reached 575,000; and other communities have grown proportionately.

Figure 2 — The Seattle plant is located on the shores of Elliot Bay, in western Seattle.

Again, historically, a rolling mill which included a small blast furnace began operations at Irondale, near Port Arthur, on the Olympic Peninsula in 1881. Later, in 1895, another small mill was started near Tacoma. Both units encountered many operating difficulties during the following years, and ceased operations ultimately.

By May, 1905, the Tacoma unit had been transferred to the shores of Elliott Bay, a location in the western portion of Seattle not far removed from Alki Point where the original settlers landed. The equipment consisted of three mills, 16, 12 and 9 in., respectively, with three furnaces and a hammer. There were no open hearth furnaces and the scrap heated for rolling was referred to as "muck bar." In 1913, a 22-in. mill from the Irondale plant was transferred to this Seattle operation.

The details of its subsequent growth are of only minor interest at this time except for the fact that the developments and improvements were gradual, keeping pace with the demands of the Northwest market. Open hearth furnaces were added one by one and mill improvements were made. By the end of 1956 the facilities consisted of an open hearth plant with five furnaces, a combination billet and structural mill and a merchant bar mill.

The open hearth shop consisted of five open hearth furnaces of 50-ton capacity, charged with 100 per cent cold metal, and fired with a combination of oil and gas. Ingots weighing 2600 lb were teemed in 13-in. square molds on three stationary plates in groups of 24, positioned around a central refractory-lined master mold and fed radially through refractory tiles. In addition to the regular 13-in. square ingots, small slabbing ingots of various sizes for rolling directly into universal mill plate were produced.

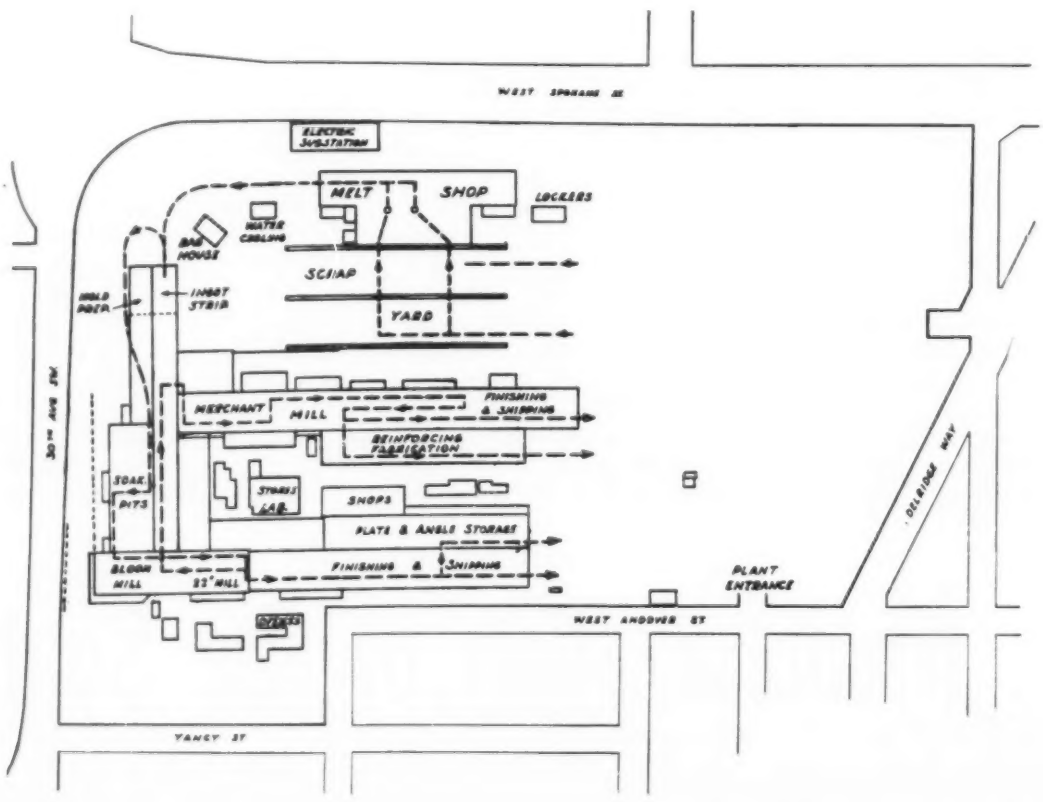
Stripping of ingots was accomplished by the use of simple tongs suspended from the overhead crane. Subsequent to stripping, the ingots were transferred to an adjacent yard where the sprues were removed and the ingots stacked ready for eventual heating and rolling.

Ingots were heated in a two-row continuous gas-fired furnace. A second double-row furnace reheated slabs and blooms.

Two 22-in., 3-high stands for reducing ingots to billets and three 22-in. 3-high stands for rolling structurals and heavy bar sections, driven by a single 2400-hp constant-speed a-c motor, comprised the combination billet and structural mill. An auxiliary 2-high stand was substituted for the last structural stand when rolling universal plate. Six traveling tilting tables served these stands.

The merchant bar mill was entirely hand operated

Figure 3 — Material flow through Seattle plant.



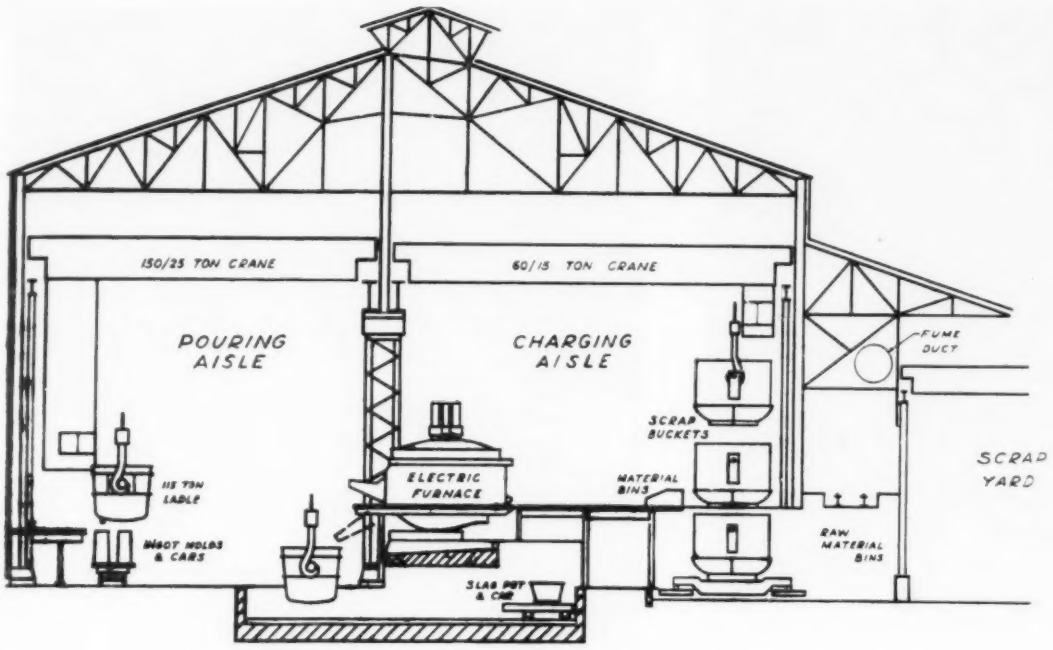


Figure 4 — Cross section through melt shop.

and consisted of two 16-in. roughing stands, five 12-in. stands and two 8-in. stands. A 2000-hp constant-speed a-c motor coupled directly to the 12-in. stands also drove the 16-in. stands by means of an antiquated rope drive. The 8-in. stands were driven by a separate 500-hp a-c motor.

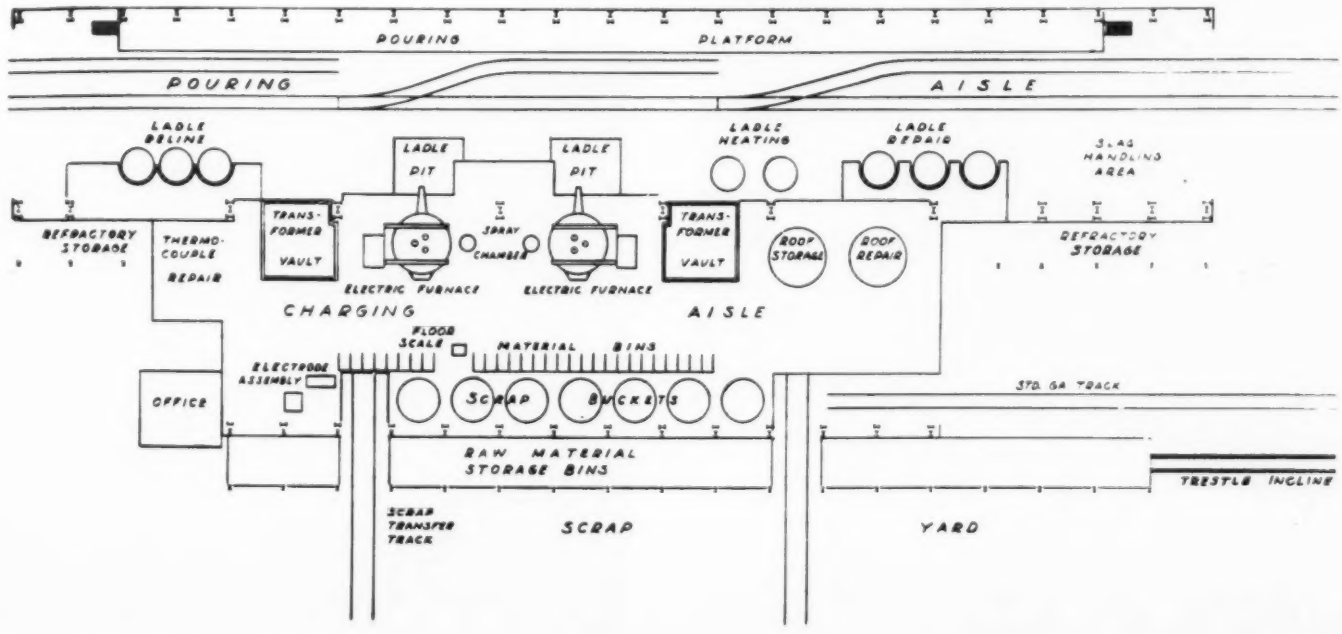
Billets from $2\frac{1}{4}$ to 4 in. square and up to 10 ft in length were heated in an oil-fired furnace. The product finished on a flat mechanical cooling bed 200 ft in length.

The Northwest population is increasing; industries are growing and new ones are entering the area; modern structures are replacing many of the older buildings in the various municipalities. With this continuing growth, the Seattle mill should also expand. However, the point had been reached where: (1) steel requirements were qualitative as well as quantitative; (2) the property which was hemmed in on four sides did not permit extensive spreading of facilities; and (3) a more efficient, economical operation was needed.

Replacing the open hearth shop with an entirely new electric furnace melt shop, installing a blooming mill with soaking pits ahead of the existing 22-in. mill, replacing the 16-12 in. merchant mill in its entirety with a modern merchant bar mill and augmenting these new producing facilities with other time-saving auxiliaries accomplished these ends. The electric furnaces are high-production units making a quality product; they require less space per ton produced than open hearth furnaces; the blooming mill permits the use of large ingots; and the new merchant bar mill is an efficient high-production unit. All three contribute to improved costs.

Figure 3 shows the general arrangement of the new plant from which one can determine the relative location of the various production units as well as the flow of materials which follow a course shaped like the letter "C." The soaking pits and blooming mill are located

Figure 5 — Plan of melt shop.



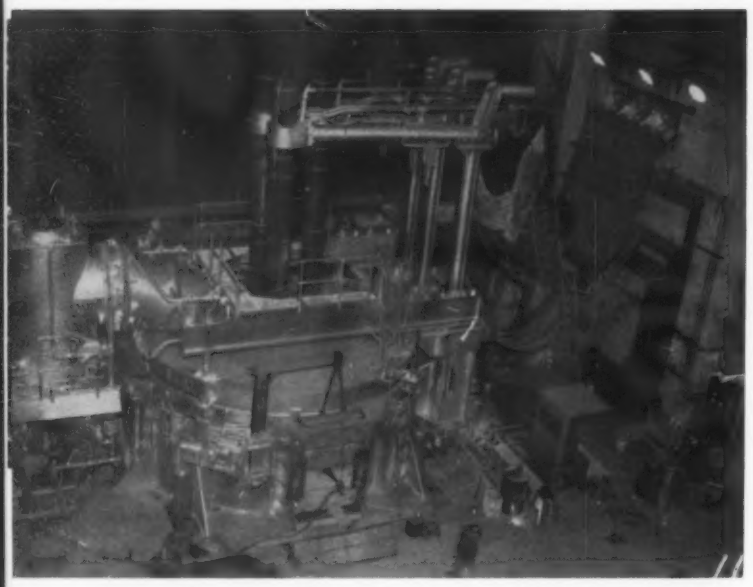


Figure 6 — Two electric furnaces have 20-ft diameter shells.

in the area formerly occupied by the open hearth shop.

The three phases of construction—melt shop, blooming mill and merchant mill could not be carried out simultaneously but had to be completed in successive steps in the order mentioned, the melt shop being completed in March, 1958.

A simple cross section through the melt shop (Figure 4) shows the building constructed with two aisles, a charging aisle 75 ft wide by 260 ft long served by one 60/15-ton crane, and a pouring aisle 65 ft wide by 440 ft long served by two 150/25-ton cranes. The crane runways are 58 ft above grade and the bottom chord of roof trusses 16 ft above that. The charging floor is 15 ft above grade.

The scrap yard is adjacent to this structure on the right. Scrap charging buckets of 1732-cu ft capacity are loaded in the scrap yard, transferred to the charging aisle and stored on the charging floor ready for charging into the furnace. It will be noted that the building is sufficiently high for the crane to carry the buckets directly over the storage area, thus avoiding a safety hazard which would exist if it were necessary to carry this equipment over the working areas. Of equal, if not of greater importance, is the need of sufficient vertical clearance when replacing electrode columns on the furnaces. A furnace is shown in its relative position between the building aisles, and ladles are shown in both tapping and teeming positions.

Figure 5 shows the plan of the shop. In addition to two furnaces and their transformer vaults, space is allotted on the charging floor for:

1. Material bins for raw materials in nominal quantities to satisfy the working of heats.
2. Storage space for eight scrap-charging buckets.
3. Furnace-roof repair and storage.
4. Electrode assembly and storage.
5. Immersion thermocouple repair.
6. Two track wells for scrap-bucket transfer car.
7. One track well at the end of the shop for standard gage.

The pouring aisle has a long pouring platform served by three spur tracks. With the rapid production of

Figure 7 — Steel is teemed into 21 x 23-in. molds set on standard gage ingot cars.

heats, adequate ladle-repair facilities are needed, so a platform is provided at the west end for ladle relining. A somewhat similar platform with fans and individual ductwork is available near the east end for the normal "between-heats" repair. Both platforms accommodate three ladles at one time. A small area at the extreme east end is intended for temporary collection of scrap and refuse. Under the charging floor at the roof-repair area the ladle stoppers are made up and fed through a continuous-type horizontal drying oven to the pit, convenient to the ladle-repair area.

The two top-charged furnaces, (Figure 6) have 20-ft diameter shells, 25,000-kva transformers with 34.5-kv primary and 173 to 450-volt secondary, air-cir-

Figure 8 — Crane is stripping 21 x 23-in. ingots.

cuit breakers, 20-in. diameter electrodes, double voltage rotating regulator controls and the newly developed rise-and-fall masts which attain speeds up to 97 in. per min. For convenience to the operators, the furnaces were placed in right-and-left hand fashion. All furnace motion is hydraulically actuated with pressures of 700 psi for tilting and 1200 psi for roof lift and swing, utilizing fire resistant fluid throughout. This system provides for 40-degree forward and 15-degree backward tilting, a roof lift of 39 in. and a roof swing of 75 degrees.

Each furnace has an actual capacity of 115 tons. Ingot weights range between 8800 and 12,600 lb; types produced are rimmed, semi-killed and killed; grades cover full range of plain carbon as well as some low alloy. Each furnace taps every four hours, approximately.

Ingot sizes have been established as 21 x 23 x 87 in. and 22 x 34 x 75 in. Both sizes are big-end-down. A third size of 22 x 24 x 81 in. is the big-end-up type. The molds are set on standard-gage ingot cars (Figure 7) in double-row fashion, the small sizes being eight to a car and the large size five to a car. After teeming (Figure 8) the ingots are transported to the stripper by means of a 65-ton locomotive. Prior to teeming, molds and stools are conditioned in a mold-preparation area adjacent to the stripping area (Figure 9).

A direct-reading spectrometer located at the metallurgical laboratory and a pneumatic-tube system together with a telautograph has accelerated delivery, chemical analysis and reporting of test samples.

No changes were made in the scrap yard other than installing two wide-gage tracks, each extending from within reach of the furnace charging crane through both 100-ft crane runways, which are directly adjacent and parallel with the shop. Traversing the two tracks is a scale car (Figure 10) with charging bucket, moved by a separate gasoline-driven tractor and equipped with load cells for electronic weighing of material and a printer for recording weights. Charges, made up with the type and proportions of scrap and other raw materials dictated by the end use of the product, are transferred to the melt shop charging floor and stored until needed.

Three, and at times four, charges are required for the usual 115-ton heat, the first charge weighing about 50 tons and subsequent charges being successively smaller. Figure 11 shows a typical charging operation, the clamshell leaves being opened by means of the auxiliary hook pulling on a dual cable fastened to the clamshell halves.

Those who have observed a large electric furnace in operation will appreciate the need for some type of fume control. Fume is drawn from these furnaces through a 34-in. diameter opening in the roof and carried downward through a water spray chamber (Figure 6) located directly to the left of the furnace and then through 450 ft of 7-ft diameter steel duct to a baghouse which contains 792 silicone-treated glass fabric bags 12 in. diameter by 25 ft long. Figure 13, showing this unit under construction, presents a good idea of its arrangement.

The water spray at the furnace is automatically controlled and its primary purpose is to reduce gas temperatures below 800 F to protect the unlined steel duct from excess temperatures. By the time these gases pass through the full length of duct work their temperature is further reduced to about 350 F which is sufficiently low for the glass fabric.

Figure 9 — Mold preparation area is located adjacent to stripping area.

Figure 10 — Charges are transferred to melt shop charging floor for storage until needed.

Figure 11 — Charge bucket has clam shell whose leaves are opened by means of an auxiliary hook.

Figure 12 — Heats usually run 115 tons.

The gases are moved by a fan of 90,000-cfm capacity, standard conditions, located at the entry to the baghouse. The whole system is automatically controlled to maintain a negative pressure of 0.05 to 0.10 in. water within the furnace.

The particulate matter is collected in hoppers below the bags and discharged into railroad cars or trucks by means of screw conveyors and bucket elevator.

With completion of the melt shop, the open hearth shop was razed and installation of soaking pits and blooming mill carried on with dispatch, and the first 21 x 23-in. ingot was reduced on the new mill seven months later. While demolition of two of the five open hearth furnaces prior to this time permitted construction in the area to proceed to some extent, nevertheless it was still limited in scope and was performed under difficult conditions. As will be touched on later, several construction problems were also encountered in this area.

The heating facilities (Figure 15) for this mill consist of two batteries of single end-fired recuperative-type pits, each group comprised of four rectangular holes with individual cover-operating mechanisms. The groups are arranged with ends of the holes adjacent, separated by a common platform, and with the burners, exhaust flues, recuperators, hot-air fans, as well as other auxiliaries located at opposite ends.

Each hole, having a nominal capacity of 16 ingots, is 8 ft wide by 22.5 ft long by 13.5 ft deep with 3 ft-4½ in. division walls, all walls being constructed of silica firestone with a top coping rammed in place.

One tile recuperator, located in the waste-gas flue, is provided for each battery to preheat combustion air to 1000 F. It is of the double-pass type on waste gas and single-pass type on preheated air.

The combustion controls as well as the pit cover and ingot-buggy operating station are located in a

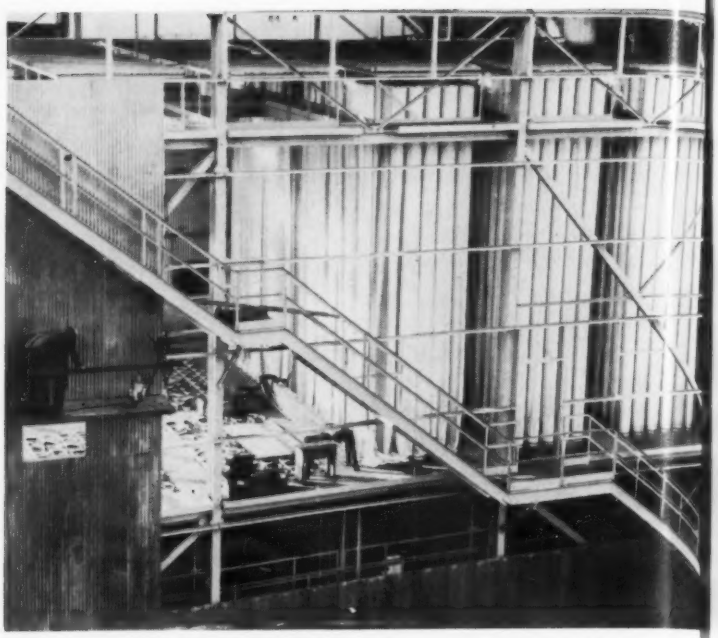


Figure 13 — Silicone-treated glass fabricated bags are 12 in. in diameter x 25 ft long.

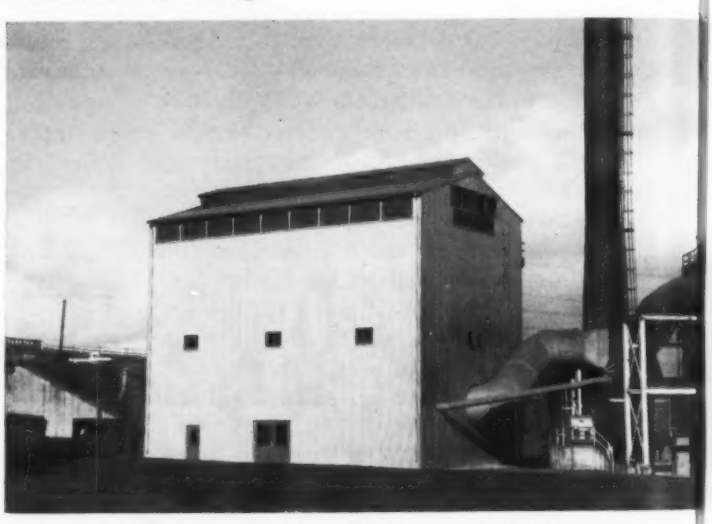
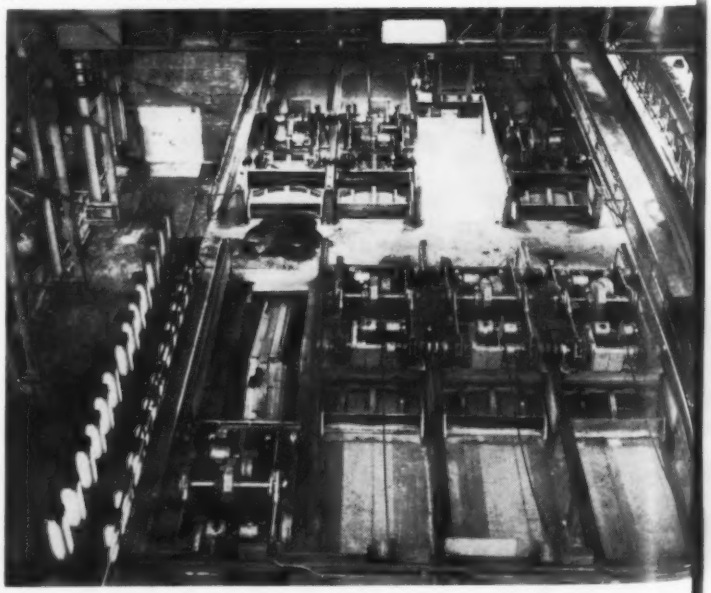


Figure 14 — To prevent air pollution a bag house was built.

Figure 15 — Two batteries of 4-hole soaking pits were part of the program.



common lean-to at the side of the building.

Charging and withdrawal of ingots at the soaking pits is accomplished by a 10-ton high-mast type tong crane operating on a runway of 90 ft span and 270 ft long. Height of the runway above grade is 35 ft-9 in. with the bottom chord of the roof trusses 31 ft-3 in. above that point. The incoming ingot track is on one side of the group of pits with the ingot-buggy loading track leading to the mill on the opposite side.

Ingots, after removal from the soaking pits, are transferred to the blooming mill table by a self-propelled ingot buggy traveling a distance of about 140 ft. The ingot, approaching the table at right angles is dumped on a platen from which a sweep arm moves it onto the mill approach table.

By means of "shoe-horn" techniques, the blooming mill with its auxiliary tables was squeezed between the existing 22-in. mill stands previously mentioned and a high and steep embankment along the edge of the property. To house this unit a section of the 22-in. mill building was removed and a new longer, wider and higher structure constructed in its place. The dimensions of this structure are 88 ft wide, 350 ft long, 35.75 ft to the crane rails with the bottom of roof trusses 14 ft above that. This building is serviced by a 60-ton crane with a 15-ton auxiliary hoist and houses the 22-in. mill as well as the new blooming mill. A desirable convenience resulting from the conversion is that the old 15-ton cranes which are on a lower level can also service the 22-in. mill units.

The blooming mill (Figure 17) a 32-in. two-high unit with a roll length of 81 in., is driven by a 4000-hp, 60 to 150-rpm d-c motor, and rolls blooms and billets down to 4-in. square.

The product of the blooming mill continues 225 ft at the rate of 365 fpm to a 500-ton shear. Broadside transfers for moving the sheared section in either direction are provided beyond the shear, one transfer 15 ft wide leading directly to the charging end of the reheating furnace mentioned in the initial remarks and the other transfer 50 ft wide leading either to a 350-ton shear or the 22-in. mill billet stand. The two shears in combination with the billet stand present an arrangement with considerable flexibility in rolling procedures.

The product, in semi-finished form, finds its way to a cooling bed 20 ft wide by 100 ft long from where it is taken by magnet to storage within the same or the adjacent building.

Adjustable voltage power for the mill motor is supplied from a 3500-kw d-c generator driven by a 3500-hp motor and a steel-plate flywheel having a stored energy of 122,000 hp-sec at 360 rpm. Rotating regulators are used to control generator and motor field forcing. A static amplifier is used for current limit of the main driving motor. The main motor and control are designed for a minimum motor reversal time from base speed to base speed in 1.5 sec.

Primary power at 13.8 kv is brought into a set of metal-clad indoor drawout switchgear. Besides the motor-generator set this unit furnishes power to a 750-kw, 250-volt d-c rectifier and a 1000-kva, 480-volt a-c unit substation.

Three rather severe construction problems were encountered: (1) the presence of subterranean water under head pressure; (2) the properties of the soil

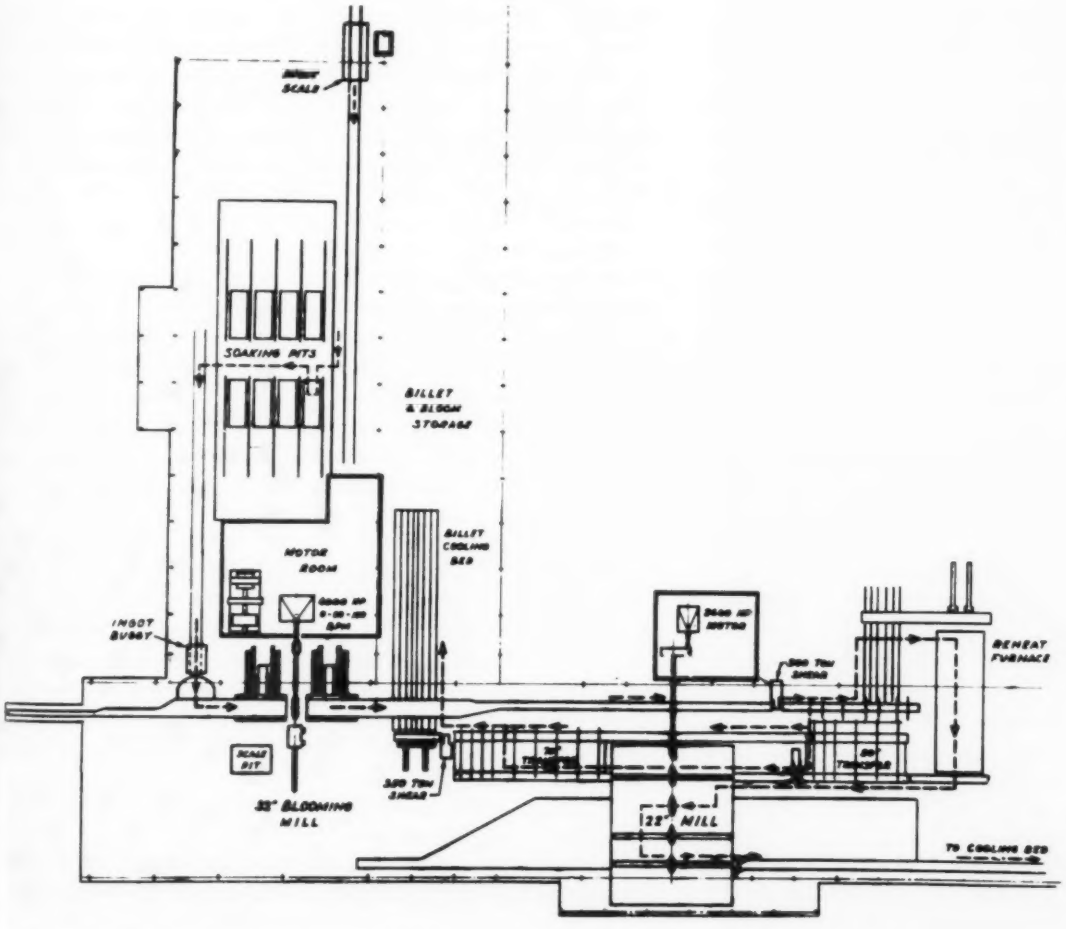


Figure 16 — Plan of blooming mill and soaking pits.

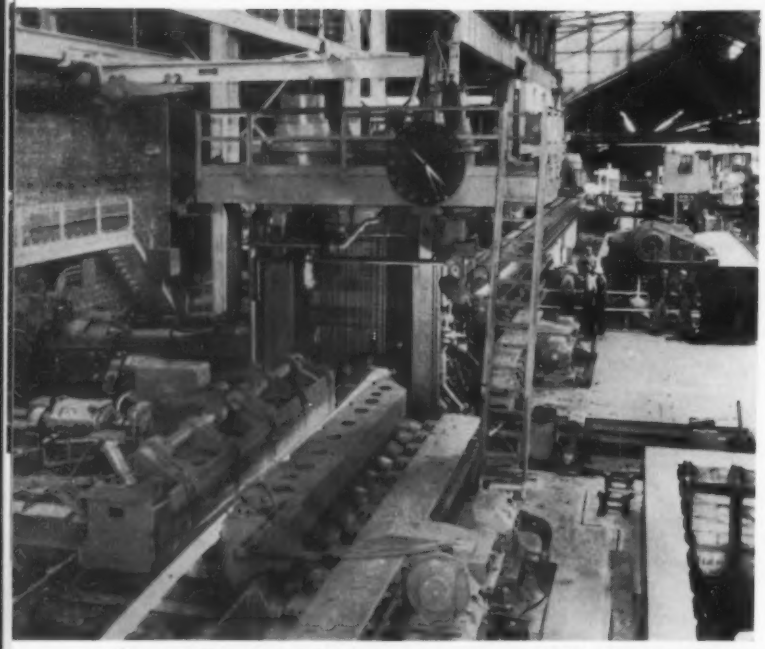


Figure 17 — Very little space was available for the 32-in. blooming mill. A 500-ton shear is shown in distance and 350-ton shear to the right of the picture. Existing 22-in. mill is just above the 350-ton shear.

Figure 18 — A sheet pile retaining wall was built to develop area for the building.

were such that final settlements of over two in. were predicted; and (3) the need to cut away the embankment to gain necessary floor space for the mill. The first problem was resolved initially by encompassing the area with deep well pumps to keep the water level low during construction. One of the larger pumps remains even now. Foundations were placed in three stages to minimize the final settlement, and grouting of equipment was held until virtually the last minute. Fortunately, the resultant settlements were not as great as anticipated, being less than one in.

To gain the needed length of building to house the mill runback tables, it was necessary to make an extreme cut into an earth bank along the one side of the plant and support the remaining earth. This was accomplished by installing a sheet-pile wall, 30 ft high at its highest point and 460 ft long, constructed of ZP-38 sheet piles driven to a penetration of 18 ft. The top section (Figure 18) was restrained by means of a continuous waler tied to 12 BP-53 H-piles spaced at 6-ft centers and driven into the bank about 40 ft at a 45-degree angle. Figure 18 shows the specially designed and constructed driving rig for this latter operation. Ironically, while the soil was unreliable for supporting loads, its character was such that driving through it bordered on the impossible.

As the construction of this wall seems of more than casual interest, Figure 19 is presented to show the general appearance of the wall just prior to completion.

Inasmuch as it is not a new facility, comments on the 22-in. mill (Figure 20) will be limited. Removal of one of the original billet stands permitted the installation of the necessary shear-approach tables. The remaining four stands are comprised of one billet stand and three structural stands, all serviced by six traveling tilting tables. A 2-high universal plate stand which is positioned, when used, in the same place as the structural finishing stand, will be replaced with a 3-high unit later this year.

In general, products produced are:

Equal leg angles	$3\frac{1}{2}$ to 6 in.
Unequal leg angles	$3\frac{1}{3}$ x 3 to 9 x 4 in.
Channels	6 to 8 in.
I-beams	4 to 6 in.
Rounds	$2\frac{5}{8}$ to $4\frac{3}{4}$ in.
Universal mill plate	6 to 30 in.

The old 16-12 in. hand mill (Figure 21) continued to operate while construction was proceeding around it much the same as it had for decades before, but after several months of operating under such handicaps, followed by a total shutdown of five weeks, the installation of the new merchant bar mill equipment was completed and ready, three months after starting the blooming mill. The new mill is contained in the same 88-ft wide building as the former 16-12 in. mill, but its appearance does not even remotely resemble the unit it replaced. Instead of seven stands there are now 14 automatically controlled stands (Figure 22) arranged in what may be termed a modified cross-country fashion.

Starting with the heating facilities (Figure 23), a new three-zone furnace, 17 ft wide by 65 ft long, with a heating rate of 75 tons per hour was provided. Fired by natural gas, it is arranged for end charge and side discharge. Billets are pushed from the furnace by a conventional ejector directly onto the mill table leading to the roughing stands.

In general there are a total of fourteen stands with four roughing stands, one 18-in. and three 16-in. arranged in tandem fashion; seven intermediate stands, three 14-in. and four 12-in., arranged in cross-country fashion; and three continuous finishing stands, the first 12-in. horizontal, the second 10-in. vertical and the third 10-in. horizontal. Three of the roughing stands are equipped with billet turners, the cross-country stands are equipped with both cross-transfer tables and looping trough repeaters.

A hydraulic dividing shear is located directly adjacent to the furnace discharge door, a flying crop shear

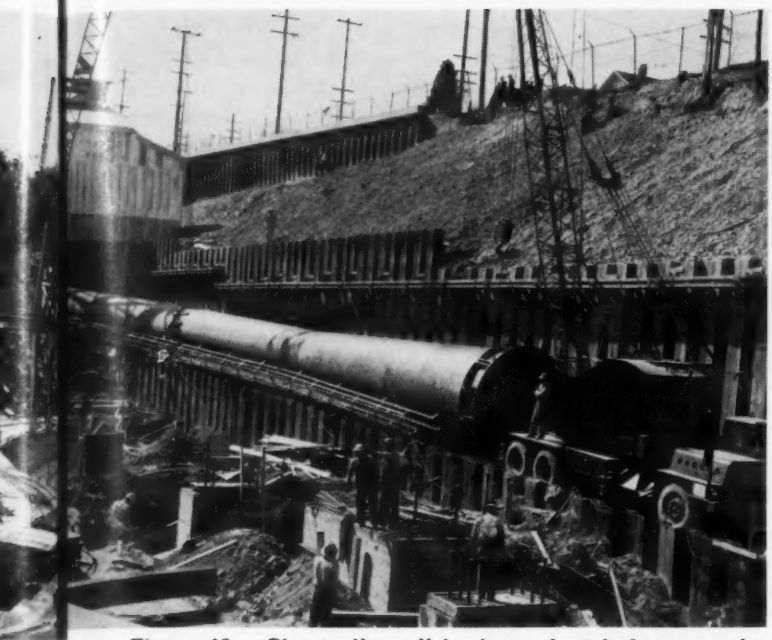


Figure 19 — Sheet pile wall is shown just before completion.

is between No. 8 and No. 9 stands and snap shears are ahead of No. 10 and No. 12 stands. A flying dividing shear is located a short distance beyond the finishing train for the purpose of cutting the rolled product into lengths appropriate for the 240-ft long cooling bed. This latter unit is a mechanical bed 13 ft wide center to center of tables, equipped with a rotating finger-type kick-off, notched carry-over bars with notches spaced 5.5 in., which discharge the product onto shuffle bars which, in turn, deposit them on the runout table. Run-in speed to cooling bed is designed for 560 to 2240 fpm.

The product is delivered to a 400-ton shear in a direction the reverse from that at which it enters the cooling bed. The shear runout table, gages, kick-off, cradles and built-in scale are of such proportions that will permit shearing and weighing bars up to 90 ft long. The platform scale under the cradles is equally divided and will weigh shorter lengths up to 40 ft on either section individually, or long lengths by using both sections as a unit. The printer records the weight in the same manner.

The first three stands are driven by a common 2000-hp, 2300-volt, a-c motor at 200 rpm through three combination drive-and-pinion stands. The power of this motor greatly exceeds the requirements for the three stands, but it was available from the original 16-12-in. mill.

Stands No. 4, 5 and 6 are driven through a common drive by a 600-hp, 600-volt d-c motor with a speed range of 400 to 800 rpm.

Stands No. 7, 8 and 9 of the cross-country train are driven by a 1250-hp, d-c motor with a speed range of 250 to 660 rpm. The last two of the cross-country mills, No. 10 and 11, are driven by a 900-hp d-c motor with speed range of 300 to 900 rpm.

The last three stands are arranged for continuous finishing and controls are provided so that their speeds can be matched. The 600-volt d-c motors driving the finishing stands are 600-hp with speeds of 400 to 1200 rpm, 350-hp with speeds of 300 to 800 rpm, and 500-hp.

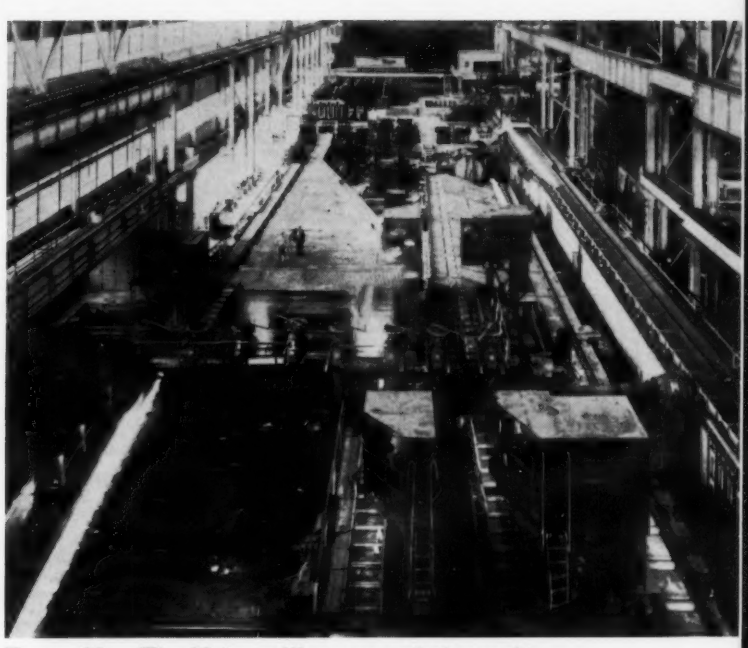


Figure 20 — The 22-in. mill was an existing unit.

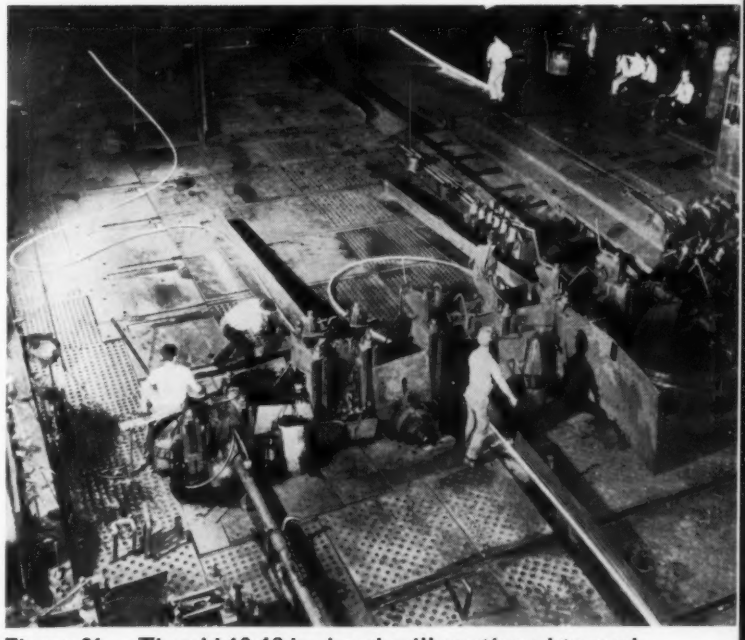
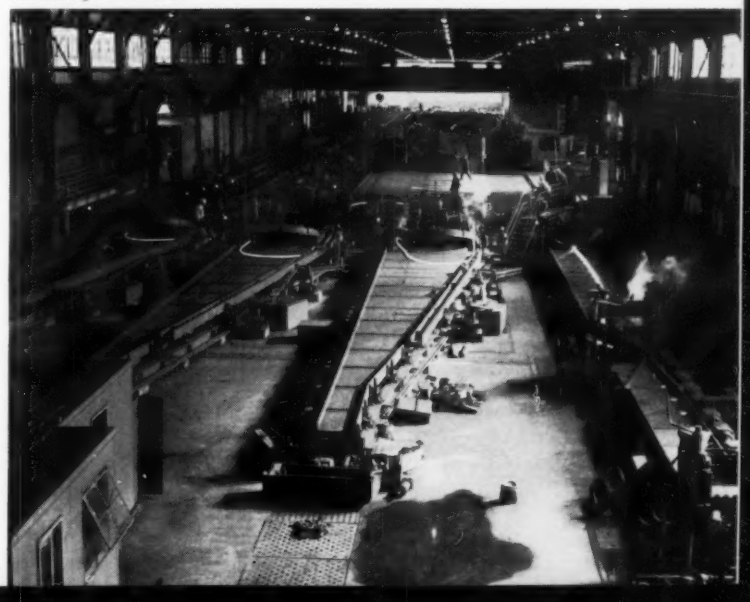


Figure 21 — The old 16-12 in. hand mill continued to work most of the time during the construction period.

Figure 22 — The new merchant bar mill has 14 automatically controlled stands arranged in a modified cross country fashion.



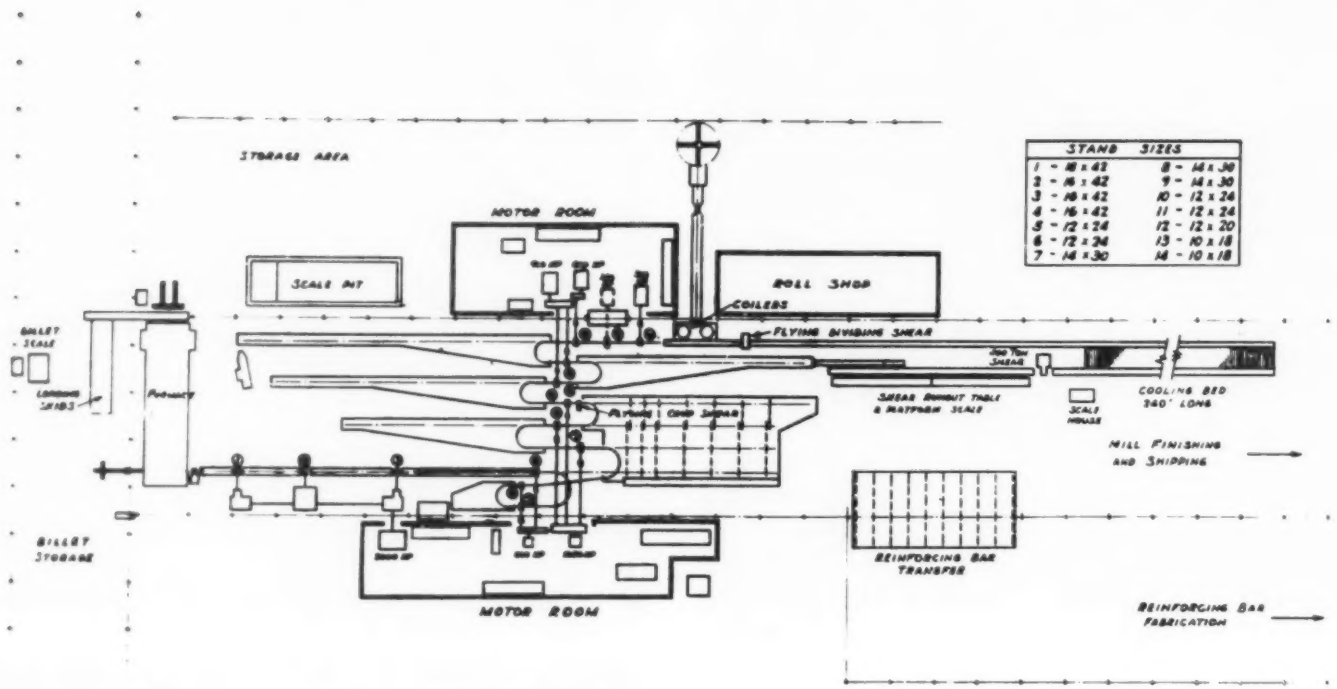


Figure 23 — Plan of new merchant mill.

with speeds of 400 to 900 rpm for No. 12, 13 and 14 stands, respectively.

From three sizes of billets, 3 x 3, 4 x 4 and 5 x 5¼ in. the following products are made.

Plain rounds	⅜ to 2½ in.
Reinforcing	No. 3 to No. 11
Flats	⅝ to 5 in. wide
Angles	¾ to 3 in.
Channels	3 to 4 in.
Nut flats	$13/16$ x $7/16$ to $1\,5/16$ x $1\,15/16$ in.

Rounds up to 1-in. diameter and nut flat sections up to $1\,1/4$ x $53/64$ in. can be produced in coil form.

With completion of this program, the Seattle plant with its new facilities will produce more steel more economically and with improved quality control. Thus Bethlehem Pacific's modernization of the Seattle plant provides "More Steel for a Growing Northwest."

Discussion

PRESENTED BY

G. L. BERRY, Chief Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

W. C. FRANKLIN, Maintenance Superintendent, Southwest Steel Rolling Mills, Inc., Los Angeles, Calif.

J. W. DePOY, Chief Engineer, Pacific Coast Div., The Colorado Fuel and Iron Corp., Oakland, Calif.

N. L. BOCK, Chief Engineer and KENNETH GRANT, Electric Furnace Superintendent, Seattle Plant, Pacific Coast Div., Bethlehem Steel Co., Seattle, Wash.

G. L. Berry: 1. With regard to the new melting shop, what were the considerations which governed the difference in elevation between the pit floor and the furnace? This dimension apparently dictated the arrangement of the depressed pouring and slag pot area.

2. The statement that four scrap buckets are required for a complete furnace charge interests me. Did the use of the existing scrap runways determine the capacity of the buckets, or was this determined by quality control considerations?

3. The application of bag filters in a gas stream at this temperature is comparatively recent. Is it possible to do more cooling with the water sprays if the bag replacements are felt to be excessive?

4. As the authors have noted, the blooming mill had to be "shoe horned" in between the existing 22-in. mill and the hillside. Was any consideration given to a new continuous billet mill as a replacement for the 22-in. mill extending toward the plant entrance to minimize the problem of retaining the hillside?

W. C. Franklin: 1. What effect does shell evacuation of electric furnace smoke have on electrode consumption and roof life?

2. What do you do with your baghouse residue after collecting it from the hoppers? Do you have any plans for possible future use of this residue?

3. What advantages do you feel you obtain from preheating the air for your reheat furnace, i.e., percentage of fuel savings, better heating, increased capacity?

J. W. DePoy: The basic problem faced by the authors is one common to many industries today, not only in steel plants but in manufacturing facilities of all types. Many of our older plants are located in areas where there is no land available adjacent to the existing plant for expansion purposes. Inspection of the Figures indicates that Bethlehem was faced with this same problem in Seattle. They were also, as the paper states, faced with the problem of increasing both quantity and quality of their production. This is the problem common to many of our older industrial plants.

The technically easy solution to this problem, of course, is to move the entire plant to a new and larger piece of land. Although no mention of the consideration of such a move is made in the paper, the description of the problems to be overcome in the actual work that was done in the plant, and the very ingenious and somewhat expensive solutions to some of these problems, would indicate that we are justified in assuming that consideration was given to moving the entire plant. Such a move, of course, presents many problems. Large tracts of land, suitable to industrial operations with adequate water supply, sewage disposal, railroad service and public utilities, are not too easy to find adjacent to our larger cities today. Even in such an extensive rebuilding operation as described in this paper, there are many portions of the plant that remain unchanged. The cost of moving or replacing these facilities can be a very considerable item. If the new plant is located at any considerable distance from the old plant, the dislocation of personnel can create a problem, particularly if the plant is located in a highly competitive labor area. It seems reasonable to assume that moving to a new and larger area was given due consideration before the rebuilding of the old plant was entered into, and that the moving solution was found wanting for good and sufficient reasons.

The substitution of electric furnaces for open hearth furnaces, in order to obtain more production per sq ft of area and to obtain a higher quality of production, is an unusual feature of this modernization program. It would be very interesting to investigate this phase a little further and to find out whether this solution is one that would be available to steel plants generally, or whether it is a solution unique to the Pacific Northwest because of the low electric power rates known to be available in that area. How much the electric furnace installation decision was influenced by low electric power rates, and how much it was affected by modern developments in the electric furnace itself is not indicated in the paper.

The elaborate equipment necessary to dispose of fumes from the electric furnaces also points out a problem common to most industries today. There are very few populated areas today where an industrial plant is not faced with severe regulations with respect to the materials it can dispose of either into the atmosphere or into adjacent waters. The Pacific Coast plants of The Colorado Fuel and Iron Corporation are also presently facing this problem of fume and sewage disposal, and we anticipate considerable expenditure ultimately to maintain adequate control. No mention is made of waste water disposal in this paper, and it is assumed that this is a part of the existing plant facility that was used in the final modernized plant.

The use of a sheet piling wall to make available space formerly occupied by the slope of an embankment was ingenious, but is an excellent example of what was meant earlier in this discussion when reference was made to certain expensive solutions to some of the problems. The expenditure is undoubtedly economically justifiable in the over-all problem, but the price per sq ft of land obtained by this expedient is certainly high.

Of particular interest to those of us located on the West coast is the indication that the modernization of this plant gives of the tremendous growth of the Pacific coast in general, and of the Pacific Northwest in particular. Another indication of the growth and development of this area is the statement that the heating furnace for the new merchant bar mill is being fired by natural gas. It has only been in the past few years that natural gas has been available in the Seattle area.

This paper has been very interesting, not only as an excellent résumé of the modernization of a steel mill, but also as a picture of the problems faced by industry in general today in any program of modernization of older facilities.

N. L. Bock and Kenneth Grant: The following are answers to questions raised in the discussion:

In general terms, two factors were responsible for establishing the height between the pit floor and the charging floor; (a) sufficient headroom clearance below charging floor for installation of piping, electrical conduits, etc., and yet provide for operations of lift trucks in handling materials and equipment; and (b) the depressed pouring pit would not be too deep. The established dimension of 15 ft appears to meet both of these requirements in our melt shop.

The charging bucket capacity is dictated by the volumetric capacity of the furnace, and as a result of observation of average conditions the volumetric capacity of the bucket should be about 80 per cent of that of the furnace. In loading a bucket the scrap can be made more dense by compacting it with the magnet, but no such opportunity exists when charging the furnace, hence the volume of the scrap in the bucket will usually be about 80 per cent of the same scrap charged into the furnace.

The relatively long duct leading to the baghouse affords ample opportunity for additional cooling of gases but experience shows such modifications will not be necessary in this installation.

No consideration was given to a continuous billet mill as a number of other important factors ruled against it.

No noticeable difference in electrode consumption and roof life has occurred since evacuating the fume and smoke through the roof of the electric melting furnaces.

Because the accumulation of residue from the furnaces began only a short time ago, no firm plans for its disposal have been made. At present it is being dumped off our property.

Recuperators were installed with the new soaking pits but not with the new billet furnace. The advantage is in fuel savings but at this time the relative savings have not been established.

All of the assumptions made by Mr. DePoy are correct. Relative to the question of whether the low power rates or the modern developments in the furnaces themselves influenced the decision to substitute electric furnaces for open hearth furnaces, it can be stated that while the favorable rates in the area were important, possibly of equal importance are the advances made in the furnace design which contribute to higher rates of production. While favorable power rates are necessary one must not overlook the need for ample power supply for future expansion as well as for present requirements. ▲

PROGRAM

AISE Western Meeting

St. Francis Hotel

San Francisco, Calif.

March 7, 8, 9, 1960

MONDAY, MARCH 7

8:30 am—REGISTRATION—
Mezzanine Floor

9:00 am—TECHNICAL SESSION—
Colonial Room

Chairmen: Frank F. Argust, Superintendent, Industrial Engineering, The Colorado Fuel and Iron Corp., Pueblo, Colo.

L. E. Ringger, Assistant Works Engineer, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Application of Digital Control Computers to Steel Industry Processes," by R. W. Kirkland, Steel Mill Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Some Applications of Computer Control in the Iron and Steel, Industry," by Dr. T. M. Stout, Manager, and Dr. S. M. Roberts, Process Analyst, Process Analysis Dept., The Thompson-Ramo-Wooldridge Products Co., Beverly Hills, Calif.

"Data Logging Techniques Applied to Processing Lines," by G. J. Hay, Steel Mill Engineer, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and W. D. Rowe, Supervisory Engineer, Digital Programming Development Section, Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

2:00 pm—TECHNICAL SESSION—
Colonial Room

Chairmen: Harold V. Gumma, Assistant Superintendent, Rolling Mills, The Colorado Fuel and Iron Corp., Pueblo, Colo.

Jackson S. Moore, Assistant Superintendent—Rolling Mill, Torrance Works, Columbia-Geneva Steel Div., United States Steel Corp., Torrance, Calif.

"The Operation of a Three-Strand High Speed Rod and Merchant Mill," by A. H. Griffiths, Superintendent of Rolling Mills, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

F. F. ARGUST

L. E. RINGGER

H. V. GUMMA

J. S. MOORE

"The Causes of Gage Variations in Hot Strip Mills and Their Correction," by Dr. R. B. Sims, Chief Engineer, Research and Development, Davy and United Engineering Co. Limited, Sheffield, England

"46-In. Blooming and Plate Mill," by J. L. Laidlaw, Manager of Engineering and Construction, and J. H. Walshaw, Superintendent, 46-In. Blooming and Plate Mill, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

"Retaining Flexibility in the Design of Mechanized Merchant Bar Mills," by Edward C. Peterson, Vice President, Rolling Mill Equipment Div., and William H. Boblitz, Roll & Mill Machinery Sales Engineer, Birdsboro Corp., Birdsboro, Pa.

TUESDAY, MARCH 8

9:00 am—TECHNICAL SESSION— Colonial Room

Chairmen: William Kinney, Assistant to Vice President of Operations, Kaiser Steel Corp., Oakland, Calif.

G. W. Teskey, Jr., Superintendent Open Hearth, San Francisco Plant, Pacific Coast Div., Bethlehem Steel Co., San Francisco, Calif.

"Cupola Metal Increases Open Hearth Production," by Wilt H. Steinheider, General Foreman, Open Hearth Dept., Sheffield Div., Armco Steel Corp., Kansas City, Mo.

"Oxygen Furnace Operation at Fontana," by W. F. Bowers, Superintendent of Steel Production, Kaiser Steel Corp., Fontana, Calif.

"Orcarb Process for the Direct Reduction of Iron Ore," by William R. Braddock, Project Engineer, Swindell-Dressler Corp., Pittsburgh, Pa.

2:00 pm—TECHNICAL SESSION— Colonial Room

Chairmen: E. F. Donatic, General Superintendent, Kaiser Steel Corp., Fontana, Calif.

W. L. Murphy, Assistant General Manager, San Francisco Plant, Pacific Coast Div., Bethlehem Steel Co., San Francisco, Calif.

"Stretch Reducing Mill Operations at Colorado Fuel and Iron's Seamless Tube Mill," by C. C. Crawford, Superintendent Seamless Tube Mill, The Colorado Fuel and Iron Corp., Pueblo, Colo.

"Philosophy of Electrical Maintenance at the Geneva Works," by H. A. Huish, Assistant Divisional Superintendent, Maintenance & Utilities, Geneva Works, Columbia-Geneva Steel Div., United States Steel Corp., Provo, Utah

"Fundamentals of Heat Distribution and Refractory Wear in Electric Steel Furnaces," by W. E. Schwabe, Product and Process Development Laboratory, National Carbon Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

"Making Lubrication More Effective as a Weapon in Management's War on Wear," by Wayne G. Ritter, President, Ritter Engineering Co., Pittsburgh, Pa.

7:00 pm—INFORMAL STAG DINNER— Mural Room

Speaker: William T. Hogan, S.J., Professor of Economics and Director, Economics Program, Fordham University, New York, N. Y.

WEDNESDAY, MARCH 9

Inspection trip to Mare Island Naval Shipyard. Buses will leave hotel at 8:30 am.

hotel reservations

Write direct for hotel reservations to St. Francis Hotel, Union Square, San Francisco 19, Calif., giving time of arrival and type of accommodation desired. Reservations should state that they are for AISE Western meeting.

transportation

Individuals or groups desiring assistance in planning their trip should get in touch with the office of American Express Co., in their respective cities or with any local travel agency.

WILLIAM KINNEY

G. W. TESKEY, JR.

E. F. DONATIC

W. L. MURPHY

Abstracts of Technical Papers

to be presented at

AISE WESTERN MEETING

March 7, 8, 9, 1960

ST. FRANCIS HOTEL SAN FRANCISCO, CALIF.

"APPLICATION OF DIGITAL CONTROL COMPUTERS TO STEEL INDUSTRY PROCESSES"

by R. W. KIRKLAND, Steel Mill Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. W. KIRKLAND

Δ DIGITAL control computers, especially designed for on-line industrial operation, are now being applied to a wide variety of continuous processes.

Over thirty of these machines have been installed or ordered for power plants, chemical and petroleum processes and for metal rolling and processing lines. These work horse computers are production tools designed to translate mathematical or logical operating concepts into efficient, uniform control of complex processes that may have a number of variables affecting production rate or quality. Fitted with individually designed and selected input-output equipment and sensing devices, these computers also automatically monitor the process, gather process and production data, reduce this data to useful information and present it to the mill operators or plant accounting system in a form that requires no further processing or interpretation.

On-line digital control computers are being tied into plant wide automatic accounting systems. Large cost savings can be realized through direct, rapid, inventory control and reduced accounting labor.

The typical industrial computer is a stored program, general purpose machine utilizing a magnetic drum or magnetic cores for its memory. It differs from its business type predecessors in that reliability, circuit simplicity and physical ruggedness are emphasized rather than high operating speeds and programming ease. The computer itself will always be the central unit in a larger system including a mating input-output cabinet and a wide variety of sensing devices, manual data input devices, data display panels, log typewriters, etc.

The digital control computer is no miracle worker but is a very fast, slavish, logic machine. It performs a sequence of operations, one after the other, according to its internally stored instructions. It can do only one thing at a time. The number of operations demanded of a control computer system must be realistically balanced against the rate at which these operations must be performed. In general the cost of such a system is in direct ratio to the number of operations multiplied by the frequency of these operations.

It is not necessary or even desirable to be a computer specialist to plan a successful control computer installation.

Each individual control computer system should be carefully integrated into the over-all plant or process system if it is to perform satisfactorily and profitably. This integration requires an intimate knowledge of the plant and the process as well as a realistic appreciation of the functional characteristics of the computer, its capabilities and its limitations.

Specifications for digital control computer systems should be prepared with the active co-operation of the users accounting, engineering and operating departments. These specifications should be functional, describing in careful detail what the proposed system is to do and when.

How it is to be done may properly be left to the ingenuity of the vendor's computer design specialists.

"SOME APPLICATIONS OF COMPUTER CONTROL IN THE IRON AND STEEL INDUSTRY"

by DR. T. M. STOUT, Manager, and DR. S. M. ROBERTS, Process Analyst, Process Analysis Dept., The Thompson-Ramo-Wooldridge Products Co., Beverly Hills, Calif.

DR. T. M. STOUT

△ THE digital control computer can be a useful supplement to conventional instrumentation in processes characterized by frequent disturbances, complex relationships between variables and conflicting objectives. Because of its cost, however, the digital control computer will be used only on large-scale processes where modest improvements in operation will justify the investment. The iron and steel industry appears to have a number of processes meeting these requirements.

Control computers can be used in a number of ways, ranging from open-loop sequence control to closed-loop optimization involving process measurements and a complex program of calculations. In the latter approach, instruments must be available for making the necessary measurements, and equations must be developed by means of which process performance can be predicted under changing conditions. These requirements present some difficulties but solutions are possible for a great many processes.

DR. S. M. ROBERTS

To illustrate these points, this paper discusses a number of possible computer applications in the iron and steel industry.

"DATA LOGGING TECHNIQUES APPLIED TO PROCESSING LINES"

by G. J. HAY, Steel Mill Engineer, Metal Working Section, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa., and W. D. ROWE, Supervisory Engineer, Digital Programming Development Section, Systems Control Dept., Westinghouse Electric Corp., Buffalo, N. Y.

G. J. HAY

△ WITH each extension of programmed control to main and auxiliary drives, the entire potential of the completely automatic mill becomes more apparent. Realization of this ideal depends in part on advancements in the art of data accumulation and feedback systems so that information can be compiled as to the actual characteristics of the process.

Initially, data accumulation systems were used in the mill accounting procedures related to the determination of productivity and product quality. Today, they represent a means for expanding our knowledge of mill process characteristics in order to accomplish

W. D. ROWE

future extensions of automatic control systems. Specifically, data accumulation systems, as they are known today, are:

1. A means of sensing information pertaining directly to the product.
2. A means of co-ordinating the information with physical location in the product.
3. A means of accumulating the information in a predetermined pattern.
4. A means of addressing the stored information with sequential readout, for permanent record, upon demand.

Systems exist today having the express function of the accumulation of data by these means. It is readily apparent that with the application of the correct sensing devices and information converters, all of the functions described, with the exception of the first, can be performed by a computer. However, a closer examination of the question reveals that computers cannot, with the possible exception of very large systems, be justified economically where the function of the equipment is data accumulation alone. The extension of system function to closed loop control may result in the computer being the most economic approach.

The constraints of the above considerations are explored more fully in the development of this paper.

"46-IN. BLOOMING AND PLATE MILL"

by J. L. LAIDLAW, Manager of Engineering and Construction, and J. H. WALSHAW, Superintendent, 46-in. Blooming and Plate Mill, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada.

J. L. LAIDLAW

△ THE mill started operations on February 23, 1959, and is unique in the fact that it has one stand serving either as a blooming or plate mill, depending on what roll train is in the mill.

As a blooming mill the rolls are 46 in. diam x 114-in. face, and as a plate mill, the work rolls are 38 in. diam x 114-in. face, with 53 x 114-in. back-up rolls.

The product range covers:

1. Slabs for plate production.
2. Blooms for rerolling in other mills.
3. Beam blanks for a 30-in. structural mill.
4. Tube rounds from 7 to 10-in. diam.
5. Sheared plate up to 104 in. wide from $\frac{1}{4}$ to $\frac{3}{4}$ in. thick.
6. Heavy plate beyond $\frac{3}{4}$ in. thick for flame cut finishing.

J. H. WALSHAW

The mill is powered by two 4000-hp, d-c motors with a speed range of 40/80 rpm, has a 42-in. edger located about 40 ft ahead of the mill, controlling slab width and edge finish.

Provision is made beyond the

mill for the future installation of a large scarfing machine, and beyond this point a large mechanical down cut shear is installed capable of cutting 650 sq in. at 1800 F.

A roller leveler, suitable for plate up to ¾ in. thick, followed by a cooling bed and complete rotary trimming, slitting and cross cut shearing line is in operation.

Two problems on the mill stand design were successfully overcome, the first, a successful dual screwdown drive arrangement for blooming and plate rolling on the same screws, and the second, a specification calling for a maximum of 30-min roll change from ingots to plate. In actual fact changing is now taking between 20 to 25 min, and with further experience and some slight modification to grease and water hose connections, can be further reduced.

"THE OPERATION OF A THREE-STRAND HIGH SPEED ROD AND MERCHANT MILL"

by A. H. GRIFFITHS, Superintendent of Rolling Mills, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

A. H. GRIFFITHS

△ IN 1953 the first thought was given to acquiring more rod mill capacity at the Kansas City plant. At that time, the revamping of the existing No. 1 rod mill was considered. The final unanimous thinking was to build a new installation on adequate grounds. Actual erection of the mill started on November 1, 1957. One thousand load bearing piling 74 ft long were driven and 14,000 cu yd of concrete were poured in the construction of this two story mill. It was determined that the most economical type of structure was obtained by locating the mill floor 14 ft above ground level. Minimum excavations, gravity sewers and accessible piping are a few of the features of this type of construction. Some 100,000 sq ft of the building is under roof.

The selection of a crew was one of the first problems faced by the production department. An agreement between the company and the union for the original staffing of the No. 2 rod mill was signed before the start up. This agreement basically attested the fact that the men would be drawn from the No. 1 rod mill and the 10-in. merchant mill. It was only necessary to select 27 bargaining unit personnel to fill the first mill operating crew, however 100 people in the seniority group were individually contacted and the contract conditions explained to them.

One turn operation of the mill commenced on June 10, 1959, and eight tons of salable No. 5 rod were produced on this date.

The mill proper is comprised of 23 closed top roll housings equipped with oil-flooded sleeve bearings. Three repeaters are located between stands No. 13 and 14, 15 and 16, and 17 and 18. Round sections are used on all three repeaters for finished rod sizes under $^{13}/_{32}$ in. No. 5 rod to $^{11}/_{16}$ in. is produced from a 2¾ in. billet, 40 ft long, weighing 1000 lb. Rounds $^{11}/_{16}$ through 1⅜ in. will be rolled from 3⅝-in. billets producing bundle weights of 1760 lb.

Billets are unscrambled automatically and fed into a two-zone, 112 ton per hr furnace. This side-charged, side-discharged furnace has hearth dimensions of 43 x 50 ft. Gas or oil may be used in the operation of the furnace with the oil being the standby fuel.

Primary a-c power for the mill is converted to direct current by the use of rectifiers. Stands No. 1 and 2 are driven off one gear reducer as are stands No. 14 and 15 and No. 16 and 17. Individual drives are used on stands No. 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13. The six-stand finishing train is driven from both ends with 1250-hp motors. The total horsepower available on the mill is 11,500.

Roller twist delivery guides are used throughout the roughing and intermediate mills. In the finish train, high-speed roller twist units of the latest design are working very satisfactory at 6000-fpm delivery speeds. No trouble is anticipated for maximum operating speeds of 6500 fpm.

Six air-cooled laying reels produce a bundle of No. 5 Rod 34 x 46 x 14 in. high weighing 1000 lb. Delay stations following the reels allow the mill to be emptied without loss of steel when trouble develops on the conveyor or hook carrier.

Air and water cooling of the rod has dropped the temperature of the finished coil to 1000 F with 0.5 per cent scale on low carbon rods.

"THE CAUSES OF GAGE VARIATIONS IN HOT STRIP MILLS AND THEIR CORRECTION"

by DR. R. B. SIMS, Chief Engineer, Research and Development, Davy and United Engineering Co., Ltd., Sheffield, England.

DR. R. B. SIMS

△ THE operation of a hot strip mill is considered, and it is shown that gage variations in hot rolled coils are due entirely to the mill, providing the slab is uniformly heated in the reheating furnace. The ways in which a continuous hot strip mill may affect the gage of strip are examined and it is concluded that in practice there are only two causes of gage variations. The first is the difference in speed between the bar leaving the last roughing stand (or leaving the reversing roughing mill at the last pass), and the speed at which the bar enters the finishing stand. This gives rise to a longitudinal temperature gradient in the bar on the delay table which is subsequently converted into variations in gage in finished strip. The other cause of gage variations is the interstand tension between the mills in the finishing train. Equations are derived both for the cooling of a bar on the delay table and for the effects on the rolling load of tension on hot strip. A case is made for the operation of hot strip mills at low, controlled tensions using a new design of interstand looper gear to control the tension. Finally, three possible configurations of gage control in a hot strip mill are examined and discussed briefly.

"RETAINING FLEXIBILITY IN THE DESIGN OF MECHANIZED MERCHANT BAR MILLS"

by EDWARD C. PETERSON, Vice President, Rolling Mill Equipment Div., and WILLIAM H. BOBLITZ, Roll & Mill Machinery Sales Engineer, Birdsboro Corp., Birdsboro, Pa.

E. C. PETERSON

△FLEXIBILITY in mechanized bar mills is affected by: (1) mill layout, (2) design of individual items of equipment and (3) roll pass design and arrangement.

Some mill layouts lend themselves to considerable flexibility, but the production is low and the labor cost is high. Other layouts eliminate manual labor entirely and lend themselves to high tonnage rates, but flexibility is adversely affected. Compromise layouts which lend themselves to mechanization and high tonnage without unduly impairing flexibility are possible. These layouts must be tailored to individual conditions, and numerous features should be considered when planning a new mill which has to do jobbing work.

W. H. BOBLITZ

The West Coast has mills at the present time which illustrate all three types of layouts.

In designing individual items of equipment for these mills, the items should be as universal as possible so that they can handle a maximum number of sections without any change of parts. Mechanical adjustments which are necessary should be simple to make. When items of equipment must be changed, they should be arranged so they can be left in the mill in an inoperative position, if possible.

Some systems of roll pass design permit variations in stock, affording changes in finished size with a minimum of groove changes. Such systems of reduction lend themselves to bar mill flexibility.

The arrangement of the various passes in the mill rolls must be studied carefully, to permit the production of the mill's complete range of sizes and sections with a minimum of roll and guide changing.

"OXYGEN FURNACE OPERATION AT FONTANA"

by W. F. BOWERS, Superintendent of Steel Production, Kaiser Steel Corp., Fontana, Calif.

W. F. BOWERS

△THIS paper relates experiences with the oxygen steelmaking operation since the beginning a year ago, and will emphasize various problems encountered. Kaiser's plant consists of three 26-ft high and 18-ft diam converters. Rated capacity is 1,440,000 tons annually. What is probably the world's largest electrostatic precipitators were built for this plant at a cost of $5,000,000.

"CUPOLA METAL INCREASES OPEN HEARTH PRODUCTION"

by WILT H. STEINHEIDER, General Foreman, Open Hearth Dept., Sheffield Div., Armco Steel Corp., Kansas City, Mo.

W. H. STEINHEIDER

△ IN order to increase production from the open hearth, two cupolas were installed in 1938 to supply hot metal. These cupolas have 108-in. shell diameters.

The cupolas are continuous cast with a slag trap in the runner which discharges the slag into an inclined trough through which water runs. The water granulates a siliceous slag permitting easy removal. The hot metal is run into a 150-ton tilting holding ladel. The metal is removed from the holding ladle into a 35-ton transfer ladel for the furnace additions. The normal metallic charge into the cupola consists of 40 per cent cast and pig iron and 60 per cent steel scrap. In addition coke and limestone are also charged.

In the first six months of 1959 production averaged 23 tons per hr with a coke rate of 6.5 to 1, a 60 per cent steel scrap charge, 15 per cent low silicon pig iron and 25 per cent cast scrap. Some 50 lb of limestone per ton produced is used as flux. Also about 10 lb of 50 per cent Fe Si per net ton produced was used to maintain desirable silicon in the hot metal. The cupola metal is delivered from the cupola at a temperature of about 2750 F with an analysis of about 3.00 per cent carbon, 0.35 per cent manganese, 0.20 per cent phosphorous, 0.13 per cent sulphur and 0.60 per cent silicon. Metal is desulphurized by introducing sodium carbonate into the stream as the metal is poured from the holding ladle.

"ORCARB PROCESS FOR THE DIRECT REDUCTION OF IRON ORE"

by WILLIAM R. BRADDOCK, Project Engineer, Swindell-Dressler Corp., Pittsburgh, Pa.

W. R. BRADDOCK

△ THE Orcarb process for the direct reduction of iron ore is now in the pilot plant development stage. This plant is fully equipped for continuous production of pig iron from ore, flux and coal. The ore is agglomerated with carbon and flux, prereduced in a rotary kiln and smelted in an electric furnace.

The advantage claimed for this process is the one-step agglomeration of very fine sized ore and flux with highly reactive carbon for rapid prereduction in the rotary kiln and subsequent low power consumption in the electric furnace.

A further incentive for development of the process is the relatively low capital cost of the plant. Estimated cost of completed facilities using this process is about half that for coke ovens, pelletizing or sintering plant and blast furnace. Capital costs of conventional blast

furnace have increased to where the economical size is now in the range of 2000 tons of pig iron per day, while the Orcarb process promises to be competitive even with units of but a few hundred tons per day.

The Orcarb process is, as follows: ore and flux are preheated in a rotating direct fired kiln to 1100 F. The hot ore and flux is then mixed with −4 mesh high volatile coking coal and fed continuously into an externally fired unlined retort. In this retort the coal as it is heated becomes plastic, picks up the ore and flux and is rolled into hard porous pellets. In this pellet the coal hardens to low temperature coke at 950 F and the carbon is intimately mixed with the ore and flux. The pellets as produced average ¼ in. diam with less than 4 per cent −4 mesh.

The agglomerates are charged into a rotating reduction kiln, where under proper time, temperature and atmospheric control the iron oxides are reduced first to FeO and then to metallic iron. In a recent test of nearly 200 hours, reduction in this kiln was 79 per cent of the iron to metallic form. This is 84.5 per cent of the total oxygen removed.

This high prereduction of the iron oxides takes place in the presence of the highly reactive carbon and with an excess of CO produced in the kiln. Combustion of the CO, supplies the heat for the reduction reactions. With maximum temperatures of 1900 F there has been no ringing or building up of the reduced material in the kiln. The prereduced material flows into the electric furnace through a connection in the roof, through which the furnace gases flow countercurrent into the kiln and there burnt.

"STRETCH REDUCING MILL OPERATIONS AT COLORADO FUEL AND IRON'S SEAMLESS TUBE MILL"

by C. C. CRAWFORD, Superintendent, Seamless Tube Mill, The Colorado Fuel and Iron Corp., Pueblo, Colo.

C. C. CRAWFORD

△ THIS paper discusses the operation of the stretch reducing mill at Colorado Fuel and Iron's seamless tube mill. This tube mill, located at Pueblo, Colo., was originally designed to cover the size range of 2⅜ through 9⅝ in. diam pipe. However, it was found that the efficiency of the smaller sizes was low and a stretch reducing mill was installed to replace a 14-stand reducing mill. This installation was completed and the first tubing was produced in October, 1956.

Since multiple lengths, rather than single lengths and larger entering shells can be used, the production rates of the smaller sizes have been substantially increased without any detrimental effect to quality and, in fact, an improvement has been noted.

Operations are described starting with the reeled shell through the reheat furnace, stretching reducing mill, sawing, cooling and handling of the finished product. The practices for producing 2⅜ and 2⅞-in. oil well tubing from a 6-in. shell and 4½-in. casing from a 7-in. shell are described as well as several heavier wall coupling stock sizes.

This installation is unique for two reasons: first, it is one of three mills operating in the United States, where tubing is produced from a reeled shell; and secondly, large shells up to 7⅝-in. diam can be stretch reduced.

"FUNDAMENTALS OF HEAT DISTRIBUTION AND REFRACTORY WEAR IN ELECTRIC STEEL FURNACES"

by W. E. SCHWABE, Product and Process Development Laboratory, National Carbon Co., Division of Union Carbide Corp., Niagara Falls, N. Y.

W. E. SCHWABE

△ UTILIZATION of refractory is a major economical factor in all melting processes. The service life of a refractory depends largely on the temperature attained during the process, and consequently on the heat radiated from the heat source upon the lining.

The paper is concerned with an analysis of the distribution of heat-density on the lining of electric steel furnaces with emphasis on the hot spot problem. A strictly theoretical method is compared with a more realistic analogy model approach. The results of this method point to several possibilities to reduce the heat differential between hot and cold spots by means of positioning electrodes and also by equalizing the power input to the furnace.

"MAKING LUBRICATION MORE EFFECTIVE AS A WEAPON IN MANAGEMENT'S WAR ON WEAR"

by WAYNE G. RITTER, President, Ritter Engineering Co., Pittsburgh, Pa.

W. G. RITTER

△ RISING repair and maintenance costs in steel plant operations is a subject of concern to responsible management. This paper cites 12 years of repair and maintenance cost versus total manufacturing cost ratios for the nine largest steel producing companies in the United States. It is of utmost importance to future manufacturing costs that wear rates of steel-producing equipment be minimized. The principal weapon, one which can do 75 per cent of the job, is good lubrication. Even though lubrication systems have been used for over 25 years and are recognized as having a beneficial effect on costs, they are not doing a good enough job today. Fourteen steps are suggested which can make lubrication more effective as a weapon in managements' war on wear. These are suggestions of a practical nature intended to show how management can use the tools now at hand to better advantage. Attitudes of operators, engineers and all workers are discussed in order to show how these affect the present state of lubrication in plants.

Powder Lancing
In Steel Mill Operations

by C. B. MILTON,
Project Engineer,
Development Laboratory,
Linde Co.,
Newark, N.J.
and L. F. KEEL,
Engineering Service Representative,
Linde Co.,
Pittsburgh, Pa.

. . . . powder lancing is primarily a melting process rather than a burning process . . . . as a result it can be readily used for piercing and cutting materials such as firebrick and concrete . . . . it may offer a number of advantages in steel plant operation, particularly in maintenance and construction applications . . . .

OXYGEN lancing is well known in the steel industry. Its use for furnace tapping and skull cutting, as examples, has been practiced for more than 25 years. Powder lancing, by way of contrast, is relatively new. Consequently, it is not as widely known despite its many advantages by comparison to oxygen lancing—particularly in the piercing and cutting of the many nonoxidizing materials extensively used in steel mills.

The oxygen lance and the powder lance are similar in one key aspect: With both, oxygen is passed through a consumable lance pipe. The powder lance goes one step further, however, in that a highly oxidizable metallic powder is entrained in and intimately mixed with the oxygen stream as it enters the lance pipe. The powder lance thus generates a substantially greater quantity of heat through the additional combustion of the metallic powder, while oxygen lancing derives its heat solely from the reaction of oxygen with consumable pipe and with the material being cut. As a result, the powder lance readily pierces and severs nonoxidizing materials such as firebrick and concrete. With powder lancing, piercing and severing are primarily "melting" actions rather than "burning" or oxidation.

Powder lancing is, in effect, a combination of oxygen lancing and powder cutting as developed during World War II for cutting stainless steel and nonferrous metals such as copper and nickel. Like powder cutting, powder lancing is supplied with metallic powder by a specially designed, pneumatically operated powder dispenser. Although recent emphasis has been on the piercing and cutting of concrete, the process has been applied quite successfully to many steel mill piercing, cutting and severing problems as shown below by example:

1. Blast furnaces—tapping salamanders prior to furnace rebuilds, opening tap holes after prolonged shutdowns, cutting up breakouts and spills for removal and general maintenance.

2. Open-hearth shops—piercing slag pocket shotholes, cleaning out slag flush holes and runners, skulling ladles and hot metal mixer lips, cleaning steel runners, moving furnace spills and break-outs and cutting oxidation resistant materials during partial or complete rebuilding of open-hearth furnaces.

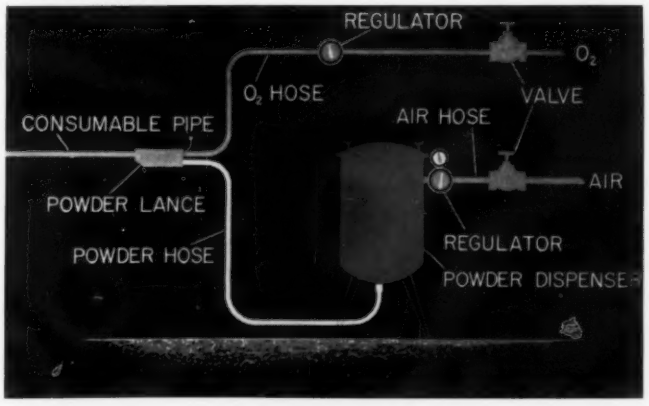
3. Demolishing or modifying concrete structures and foundations.

PROCESS EQUIPMENT

General requirements—Four consumable products are required. These are high-pressure high-purity oxygen, high-pressure dry air, standard black iron pipe, and powder. The powder is a specially processed and blended mixture consisting of 85 per cent iron and 15 per cent aluminum by weight. The apparatus includes a powder lance handle and powder dispenser with appropriate hose and regulating equipment. A typical powder lancing setup is illustrated in Figure 1.

The oxygen is taken from an adequate supply line as illustrated, or it may come from a bank of manifolded cylinders. From its source of supply, the oxygen

Figure 1 — Schematic shows operation of typical powder lancing setup.



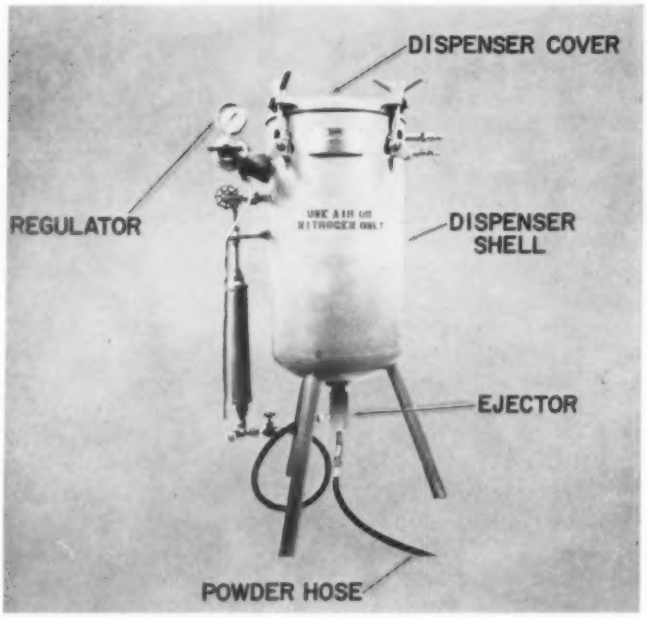


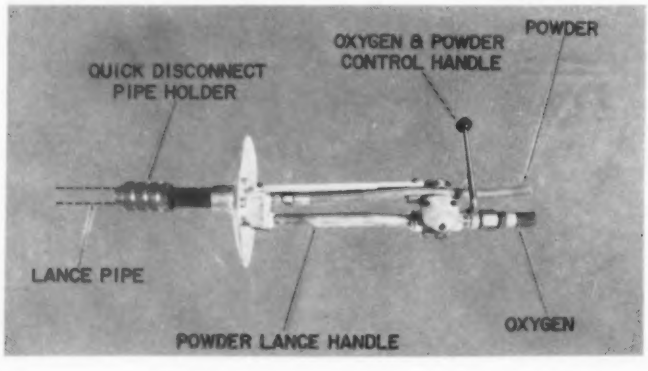
Figure 2 — Powder dispenser has three basic components.

passes through a proper flow regulator and hose to the powder lance handle. The air is similarly taken through a hose to the powder dispenser. In this case, the air-flow regulator is an integral part of the dispenser. Powder flow is metered as the powder leaves the dispenser through the ejector on the bottom. The powder and powder-conveying air then pass through a hose to the powder lance handle. At this point, the oxygen and powder are mixed and flow through the lance pipe to the reaction zone.

Powder dispenser—Figure 2 is a close-up of the powder dispenser, which has three basic components—the air supply regulator, the pressurized shell into which the powder is charged and the ejector through which the powder is metered as it flows into the powder hose on its way to the powder lance handle.

The air for conveying the powder must be dry. If entrained water from the air supply enters the dispenser, oversized powder globules will form and ultimately clog the metering device. This will cause erratic powder flow and eventually complete flow stoppage. A suitable commercial water trap is, therefore, strongly recommended for installation in the air supply line. On the dispenser, itself, a small cylinder is mounted vertically. This is a replaceable silica gel capsule for removing minute traces of moisture. Its effectiveness, however, is nullified unless dry air is used. Thus, in remote areas when dry air is not available, cylinder nitrogen is quite suitable as a powder-conveying gas. The dispenser is charged with powder by removing the cast cover from the shell. Upon replacing the cover and pressurizing the shell, the correct powder flow is set by adjusting the ejector.

Figure 3 — The holders supplying oxygen and powder meet in the powder lancing handle.



Powder lance handle—A powder lance handle is shown in Figure 3. It is here that the individual hoses supplying oxygen and powder finally meet. The two consumables are mixed and exit from the powder lance handle through the lance pipe. The single lever valve mechanism at the rear of the handle controls the "on" and "off" flow of oxygen and powder.

For safety reasons, powder should never be allowed to remain in the lance pipe or lance handle when the apparatus is not in use. To ensure this, the oxygen and powder valve mechanism is designed to provide: (1) that oxygen flow begins slightly before the powder flow begins when starting lancing operations, and (2) that powder flow ceases before oxygen flow when stopping operations. With this sequence, the lance handle and pipe are always purged free of powder when not in use. In addition, the valve mechanism permits the use of oxygen without powder. On certain occasions, this is a decided advantage since there are times when the use of powder is neither necessary nor desirable. Without powder, the powder lance reverts to an oxygen lance.

Actual mixing of oxygen and powder takes place in the front body of the powder lance handle. Mixing, however, does not occur until both have reached the consumable pipe as separate streams of flow. This too provides an additional measure of safety. The pipe holder mounted on the extreme front end of the lance handle is a "quick disconnect" mechanism that makes it possible to remove the consumed pipe stubs quickly and to connect new lance pipe ready for use. Downtime, therefore, is kept to a minimum. The pipe holders are available in three sizes for handling ¼, ⅜ and ½-in. standard black pipe. The pipe must be clean from oil and grease. If not, flash burning may occur in the oxygen atmosphere.

PRINCIPLES OF OPERATION

During combustion of the metallic powders, large quantities of heat are generated at temperatures sufficient for melting the usual industrial building materials and refractories. The oxides, of course promote slag fluidity. The continuous blast of combustion gases forces this molten material away from the area being lanced. Two basic operations are performed with the powder lance—piercing and washing.

Piercing—When piercing a hole, the lance pipe is held against the surface of the material to be pierced. As hot gases and the burning powder come into contact with the surface, heat is transferred to the surface. The material then melts. As the material keeps melting, the operator pushes the powder lance pipe forward so that it continues to burn a relatively round hole deeper and deeper into the material. The hot gases purge the molten material from the deepening hole.

The hole piercing operation is illustrated in Figure 4. As may be seen, the hole is inclined slightly upwards and away from the lance handle and operator. With this slight incline, the molten material can flow more freely from the hole. During the piercing operation,

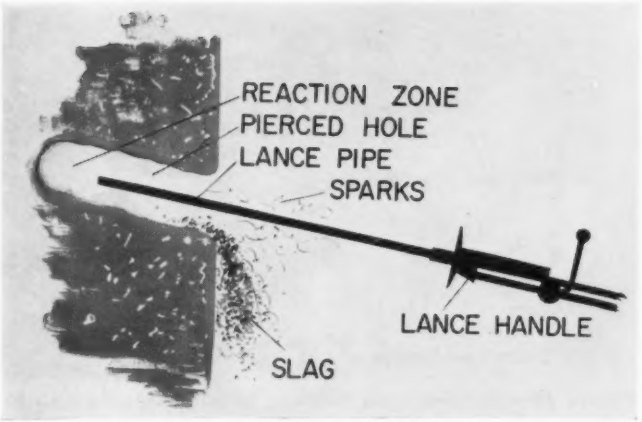


Figure 4 — In hole piercing, the hole is inclined upward so molten material can flow freely from hole.

the lance pipe is held to within two to four inches of the bottom of the hole. As piercing continues, the lance pipe is moved forward in order to maintain the most effective piercing distance. During this operation, the lance pipe is being consumed. When the lance pipe becomes too short for further use, the remaining pipe stub is quickly removed from the lance handle. A new piece of lance pipe is then attached, and piercing continues.

Washing—As seen in Figure 5, washing differs from piercing in that the reaction is used to cut a slot or channel rather than to pierce a deep hole. As the lance pipe is slowly moved back and forth through the slot, the bottom of the slot is melted and "washed" away. With this continuous action, a channel of ever increasing depth is cut. Because of its high degree of fluidity, the hot slag flows out through the bottom of the slot. The final result is a complete cut through the base material, as illustrated in Figure 6.

Powder requirements—As previously mentioned, a mechanical mixture of powders is used. The mixture consists of 85 per cent iron powder and 15 per cent aluminum powder on a weight basis. The aluminum addition increases the reaction temperature and the total available heat. Experience has proved the 15 per cent aluminum addition to be optimum. Any process benefits, which would be derived from a greater aluminum content, are more than offset by increased powder costs. The powder is specially sized and blended for efficiency both in process operations and economy.

Although the iron and aluminum powders can be mixed on the job site, this is not generally recommended. Premixed mixtures for powder lancing use are available on the market. The premixed feature has definite advantages such as follows:

1. No need for laborious, time consuming and costly mixing operations at the job site.
2. The assurance that the powder has the correct screen analysis and proper blending for best flow characteristics and burning qualities.
3. The control of powder costs by eliminating the possibility of using excessive amounts of high cost aluminum.

During normal operations, the amount of powder used ranges from 120 to 240 lb per hr depending primarily upon the size pipe being used. However, powder flow may be increased or decreased for a given

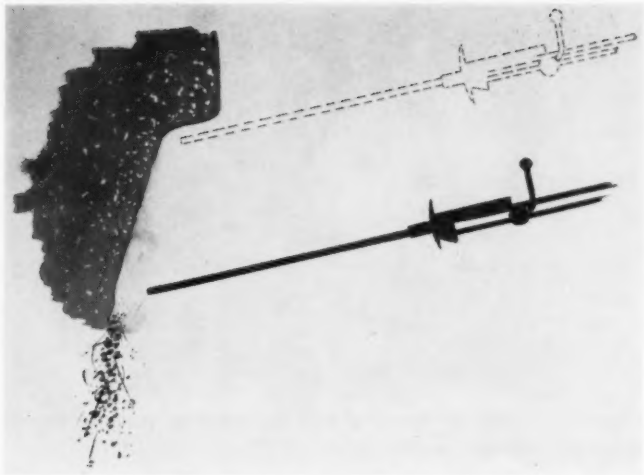


Figure 5 — Washing differs from piercing in that a slot or channel is cut.

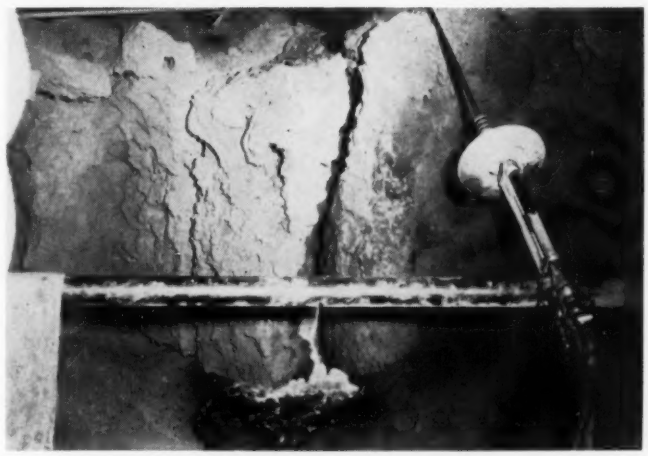


Figure 6 — Illustration shows washing action.

pipe size if advantageous to do so. At the same time, the oxygen flow rate varies between 2500 and 5000 cfhr.

Safety—All safety requirements normally applying to the handling of oxygen and oxygen equipment and to the use of powdered materials also apply to powder lancing. For example, safety glasses should always be worn. Body protection from the hot reaction gases and the flying molten, sticky particles should be provided for operators in the form of noncombustible clothing such as leather or asbestos coats, pants and aprons. Face protection should be provided along with gloves, high top shoes and hard hats. Whenever possible, the work should be done from behind a safety shield.

STEEL MILL APPLICATIONS

Blast furnaces—Powder lancing first gained recognition in 1952 for opening tap holes after a prolonged bank. During a long bank, the furnace hearth, its salamander and overlying slag layer cool and solidify. As a result, use of conventional methods for tapping the first cast through this cold, solid material may prove slow and laborious. Oxygen lancing, as well as other improvised tapping methods, often requires many hours. Powder lancing as illustrated in Figure 7, however, is relatively rapid. In one instance, a powder lance was employed to open tap holes after a 54-day bank in less than 30 minutes; the most stubborn holes required only one hour. In a more recent operation, a

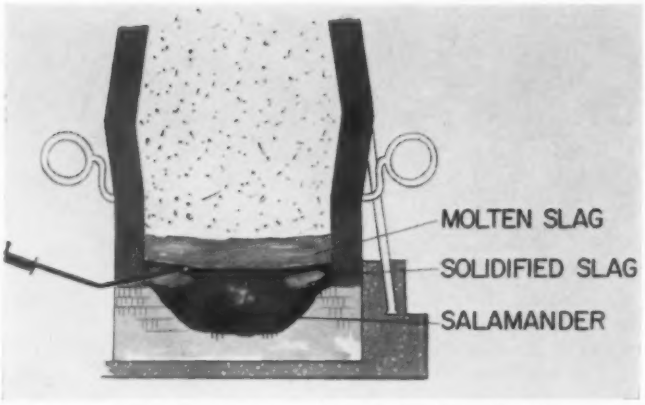


Figure 7 — Powder lancing aids in tapping blast furnaces after a prolonged bank.

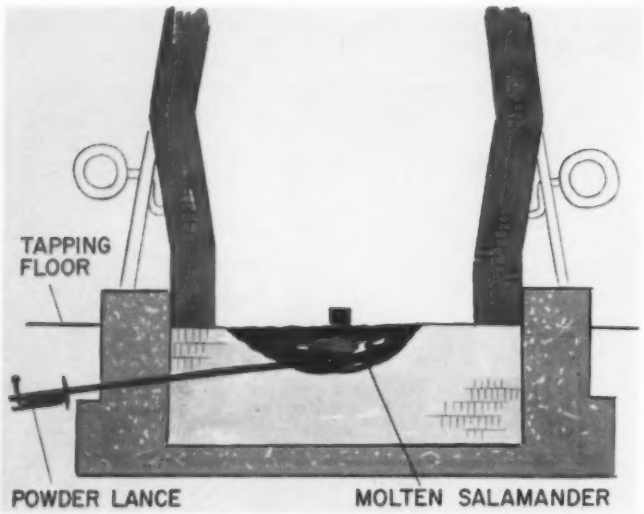


Figure 8 — The powder lance can be used for draining the molten salamander when furnace is down for a rebuild.

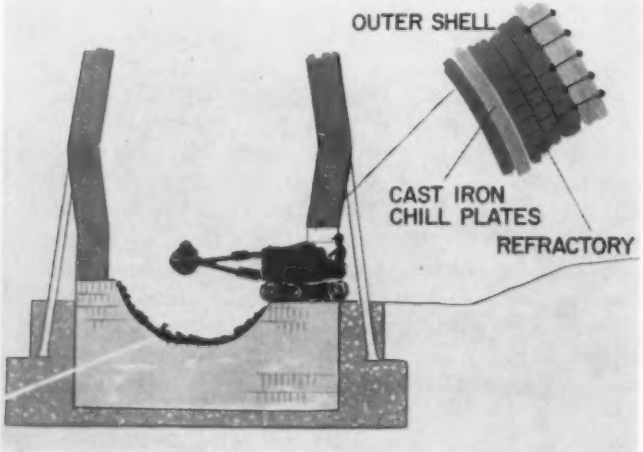


Figure 9 — Breaking into the bottom of the blast furnace enables the operator to easily get mechanical equipment inside the unit.

blast furnace on a bank for 18 days was opened for the initial tap in 20 minutes over-all time. In this application, the lancing technique remains the same whether one is employing the oxygen lance or the powder lance. The increased effectiveness results directly from the use of powder. Because of its lighter weight and greater flexibility, $\frac{3}{8}$-in. pipe has proved most suitable for this job.

Figure 8 shows the powder lance being used for tapping and draining the molten salamander when a

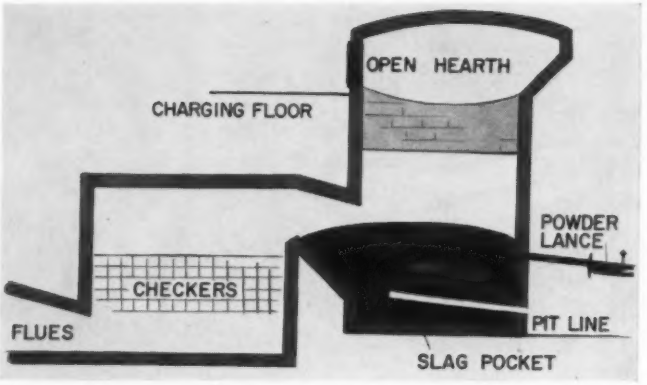


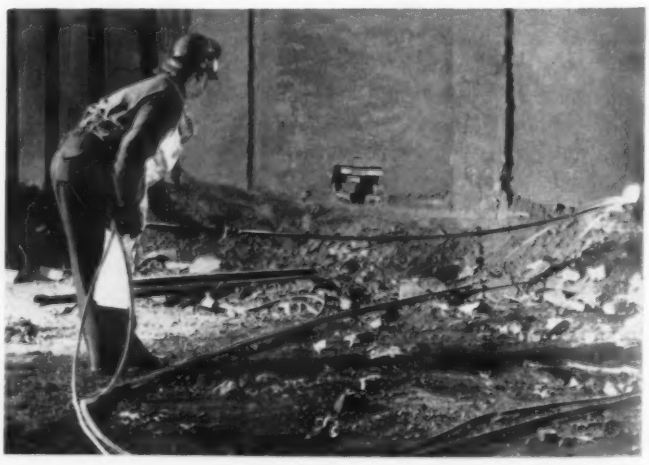
Figure 10 — In the open hearth, powder lancing can be used in slag pockets.

blast furnace is down for rebuild. In this application, the operator can pierce the drain hole easily and in a minimum time interval—usually 30 minutes of lancing time. Care is necessary to provide a line-up so that the operator simply pierces straight forward on a predetermined line. Someone skilled at estimating the bottom of the salamander determines the line-up. In this specific example, powder lancing is used as a substitute for the oxygen lance and/or mechanical drills. Its big advantage is its increased piercing speed. Figure 9 is a schematic of a blast furnace after the molten salamander has been drained. In this case, the powder lance has also been used to pierce blast holes in the solid part of the salamander, which was afterwards blasted. The powder lance can be used to open up sides in the blast furnace so that mechanical equipment can be brought into the furnace to remove the debris.

In addition to its use for opening tap holes and for removing salamanders, the powder lance is used for removing break-outs and spills as well as for cutting cast iron runners for removal and for general cleanup and maintenance. In most maintenance, cutting and clean-up operations, washing rather than piercing is employed.

Open-hearth shops—The powder lancing of slag pocket shot holes in open-hearth furnaces is illustrated in Figure 10. This is typical of the many applications for the powder lance in open-hearth shops. In the rebuilding of open-hearth furnaces, it is necessary to blast the slag pockets for removal. This may be done with mechanical drills. However, the slag is quite often

Figure 11 — Here the operator is just beginning to pierce the hole.



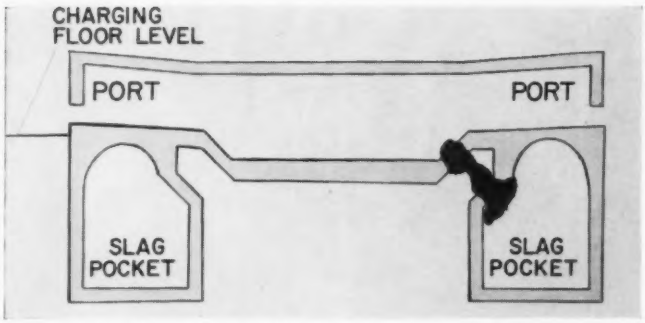


Figure 12 — Powder lancing is very effective in removing hearth break-outs.

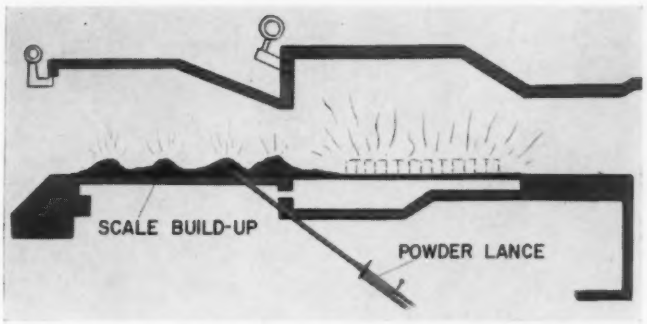


Figure 14 — Scale buildup in continuous reheating furnaces can be removed by powder lancing.

very hard and very hot. Thus, many hours and many tool bits may be required to prepare blast holes. When using the powder lance for this application, usual practice is to make three 8-ft deep blast holes in each of the two slag pockets. This is generally accomplished in one turn by an operator, and can be done up to 10 days prior to furnace shutdown. When the furnace is shut down, the shot holes are immediately chilled with a water stream and the pockets are blasted shortly thereafter. Removal can then begin on the blast debris. An action view of shot-hole piercing is illustrated in Figure 11. The operator is just beginning to pierce the hole. As he pierces, he will walk forward toward the hole as the pipe is consumed. The work is being done while the furnace is in operation.

Another open-hearth shop application is illustrated in Figure 12. The problem is that of removing a hearth break-out. The break-out consists of a mass of steel, firebrick, and hearth refractory as well as other materials. Ordinarily this break-out would be cut for removal by oxyacetylene cutting, oxygen lancing, and by pulling and lifting with a crane. In the case of serious break-outs, removal and clean-up could last many days. However, time losses are reduced when using the powder lance with its ability to rapidly cut fire brick, hearth material and other nonoxidizable materials.

When rebuilding open-hearth furnaces—especially larger furnaces—it is often impossible to lift the old hearth bottom out of the furnace in one piece in order to replace it. It is, therefore, necessary to break or cut the hearth bottom into pieces small enough for removal. The powder lance effectively cuts the bottom into handling sizes. Sometimes it is only necessary to cut the bottom into two pieces starting from the middle charging door back to the tap hole. In extra large furnaces, however, it might be necessary to cut the bottom into three or even four pieces for expeditious removal. Thus, quite often, an extremely large amount of time is saved in rebuilding the furnace.

Another important application for powder lancing in open-hearth shops is illustrated in Figure 13. This is ladle skulling. Through use, a heavy and tenacious ring or "skull" builds up around the top of the ladle. With a powder lance, the skull can be cut through in two or three places. Upon cooling, the skull contracts and frees itself for easy removal. Removal is then accomplished either by pulling the skull out with a crane hook or more often by simply turning the ladle upside down and dumping. A skilled powder lance operator can cut the skull without seriously damaging the brickwork. It is, in fact, not unusual at all for the skull to be cut and removed with a minimum of brick repair work.

General maintenance and scrap cutting—In addition to applications that have been described, powder lancing is used in open-hearth shops for cutting spills and for general maintenance where it is necessary to cut or remove slag-encrusted furnace parts or to cut or remove items hard to handle with standard cutting equipment. Powder lancing may be used elsewhere—for example, in the removing of scale buildups in continuous reheat furnaces as shown in Figure 14. As the slabs move through the furnace, falling scale often collects and builds up so as to retard movement of the slabs. On occasion, a slab will climb up on the slab proceeding it. To prevent this, it is necessary at times to flatten out or remove the buildups. The powder lance may be used to break and loosen the buildup so that the debris can be smoothed down or raked out with long rakes.

As shown in Figure 15, the powder lance can also be used quite effectively in scrap yards for reducing all types of scrap to recharging size. The powder lance does not replace drop balls, jack hammers, or cutting torches. It does, however, very effectively complement other equipment. It can be used to do a complete job of cutting, or it can be used in conjunction with the other methods. Very often powder lancing is used to weaken the scrap material for easier breaking with the ball.

Figure 13 — Powder lancing is also quite effective in skulling ladles.

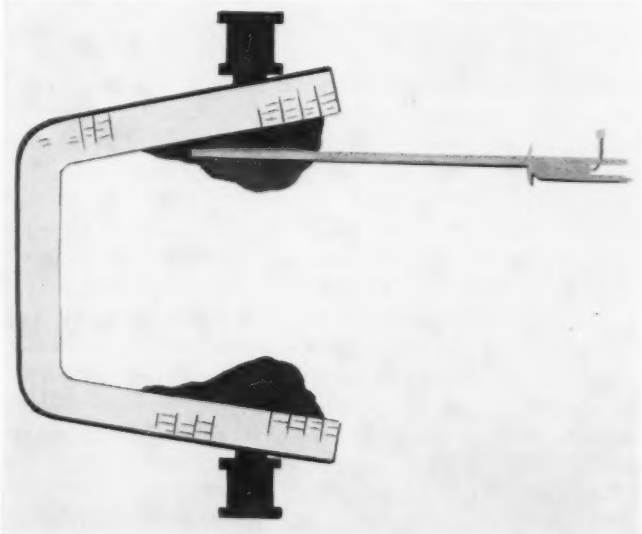


Figure 15 — The powder lance has been used for some time in reducing scrap to recharging size.

Figure 16 — This concrete slab was cut from a 3-ft thick wall.

Figure 17 — All safety precautions should be taken when using the powder lancing process.

Figure 18 — This concrete core is an example of the size which can be cut out in one piece.

Figure 19 — The operator is making a vertical cut in a concrete floor.

CONCRETE CUTTING

Powder lancing is proving to be invaluable for modifying and demolishing heavily reinforced concrete foundations and structures. This is especially true: (1) where time is of prime importance, (2) where cutting along a predetermined line is necessary and (3) where the vibrations and noise of jack hammering and blasting are not permissible. It is not presumed, however, that powder lancing will replace other methods of concrete cutting for normal work that is not too difficult. Generally speaking, the concrete must be massive and must be heavily reinforced for powder lancing to be competitive with other concrete cutting methods. If reinforcement bars are not there in quantity, other methods can rapidly break the concrete away. In contrast, reinforcing bars are no hindrance to powder lancing. In fact, the steel bars burn and add to the reaction, thereby increasing the cutting speed.

In Figure 16, the viewer can see a concrete slab core that has been cut and removed from a 3-ft thick concrete wall. The two sides as well as the top and the bottom of the doorway were "washed" with the powder lance. A cable was then used to pull the slab out of the opening for subsequent removal. This particular job required 17 hours by a single two-man lancing crew. Figure 17 is an action shot taken while the work was being done on the doorway shown in Figure 16. This view emphasizes the extremely hot reaction that takes place at the end of the lance pipe. It also clearly indicates the need for adequate safety precautions—for example, safety glasses and complete protective clothing. It also illustrates the type of protective shield that should be used to protect the operator from the flying globules of molten slag.

Figure 18 shows the concrete core that resulted when

a tunnel was cut through a 10-ft thick heavily reinforced concrete wall. In this view, the core, which was removed in one piece, has been loaded on a semi-trailer for hauling away. Light and dark areas may be seen on the cut surfaces. The dark areas are layers of solidified slag that have not been broken away. Conversely, the light areas are the clean surfaces left on the concrete after removal of the easily broken away slag. Powder lancing dehydrates and weakens the concrete only to a depth of approximately 2 in. from the cut surface. In Figure 19, the operator is making a vertical cut in a concrete floor. When completed, a 7-ft diameter core had been cut from an 8-ft thick heavily reinforced floor. The core, weighing approximately 13 tons, was lifted from its hole in one piece by an overhead crane.

SUMMARY

By using the powder lance, it is possible to pierce or cut all refractory and building materials encountered in steel mills as well as the most heavily reinforced concrete. The powder lance is, therefore, a valuable tool in steel mill operations. Its use does much to reduce downtime and to increase maintenance effectiveness and efficiency. Once this tool is placed in operation, many uses for it are readily found in addition to those which have been outlined here.

Discussion

PRESENTED BY

WAYNE TUCKER, Maintenance Engineer, Gary Steel Works, United States Steel Corp., Gary, Ind.

C. B. MILTON, Project Engineer, Development Laboratory, Linde Co., Newark, N.J.

JOHN P. DOUGLAS, Metallurgist, Research and Development Dept., Indiana Harbor Works, Inland Steel Co., East Chicago, Ind.

Wayne Tucker: The applications cited certainly are sufficient criteria to indicate continued and expanded use in future steel mill operations. I do have some questions.

First, what is the consumption ratio of high pressure dry air or nitrogen to oxygen in the powder lancing process?

Second, is the specially processed and blended mixture you recommend best for powder cutting as well as powder lancing?

Third, are there any specific advances in your company's powder lance which tend to antiquate prior lances?

C. B. Milton: The first question concerns the consumption of powder-conveying air or nitrogen in the powder lancing process. This requirement is approximately ten per cent of the oxygen flow. The ratio of air or nitrogen to oxygen for a particular application will, however, increase or decrease slightly with the need for a greater or smaller powder flow. Depending upon the pressures and pipe size being used, oxygen flow will vary between 2500 and 6500 cfhr. The powder conveying air flow will then be 250 to 650 cfhr.

Mr. Tucker asks secondly if the specially processed and blended powder recommended for powder lancing is also best for powder cutting. The answer is no. Experience has proved that the most efficient powder for powder lancing consists of 85 per cent iron powde and 15 per cent aluminum powder. Any process ad vantages that might be realized through a higher percentage of aluminum is more than offset by increased powder costs. Powder cutting is usually applied either to stainless steel or to nonferrous materials such as copper, nickel or concrete. The cutting of stainless steel requires iron powder only. For cutting other materials, a 70 per cent iron and 30 per cent aluminum powder mixture is recommended as being most efficient. In addition, the powder particle screen analysis best suited for powder lancing is quite different from that found best for cutting.

The third question concerns advances or improvements in powder lancing apparatus that tend to antiquate prior apparatus designs. In this case, the answer is yes. The powder lance handle now recommended is the fourth in a series. Each successive model has been designed to incorporate improved wear resistance and ease of maintenance. The presently recommended powder lance handle has the simplest design of the series. Yet, it suffers the least amount of wear from powder abrasion while affording the greatest ease of repair once excessive wear has occurred. At the same time, it provides the most efficient powder and oxygen "on-and-off" control sequence of the series. This lance handle has been thoroughly field-tested. No major changes in this basic design are anticipated for the future.

Another major improvement in the powder lancing process resulted with a relatively new design powder dispenser ejector. This ejector provides constantly smooth powder flows without pulsations and stoppages. No longer is it necessary to shake a dispenser to maintain a flow of powder as in the early days of powder process usage. The new ejector is now a standard part of all powder lancing dispensers.

John P. Douglas: I would like to ask if you have ever experienced any flashbacks from the operation of the powder lance and feeding system; that is, has the flame at the lance tip ever moved back through the tubing into the powder dispenser? Also, how would you guard against or counteract an unfavorable occurrence of this sort?

C. B. Milton: Yes, we have encountered flashbacks in the past during powder lancing. Generally, the flashing occurred in the lance pipe or lance handle. We do recall, however, one instance in which the flash traveled back to the dispenser. The great majority of flashes or burnouts occurred when powder lancing was still relatively new. At that time, intensive studies were initiated to determine the causes of flashbacks and to provide preventative measures. As a consequence, powder lance flashbacks are now almost nonexistent. This results from improvements in powder lancing powder mixtures, powder lance handles, dispensing apparatus, operating conditions and techniques. The simplest and most direct answer to your question for guarding against flashbacks is to say that one should follow recommended process instructions and procedures. In addition, as with any cutting or lancing process, good safety practices should be followed. As you recall, we specified that only pipe that is cleaned free of oil and grease should be used. These products in an oxygen atmosphere can cause flashbacks in the lance pipe. This, however, is a condition that only the user can control. ▲

Spray lubrication of roll necks has solved a number of mill maintenance and operating problems

Spray Lubrication Of Roll Necks

By ALFRED A. PAUL,
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The Brooks Oil Co.
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THE roll neck bearing is one of the most important rolling mill component parts necessary in the rolling of steel. Satisfactory product and economical production of same is dependent on the best possible performance of these bearings. Failure results in mill downtime, costly repairs and loss of production yield.

Bearing and journal performance is most often determined in terms of tonnage rolled, however, other factors such as lubrication cost, installation and replacement and power cost from frictional drag demand some consideration. There is attention given to roll neck bearing design for the new modern mills and this is toward antifriction bearings. There are existing mills using enclosed precision-type babbitted journal bearings with good results and there probably will be many more in the future. Bearing improvements for use on existing old and somewhat slow mills will possibly be toward fabric with improved scale guards.

There are many mills of long service rolling high tonnage with babbitted bearings and bronze thrusts that will continue rolling many years to come. Whether it be blooming, slabbing, plate, billet bar mill or hot sheet mill operations, a desire for increased production at minimum cost is ever paramount.

We should point out that there exists a difference of opinion on design and operation from one mill to another. The lubrication engineer may prefer one method of lubrication over another. Bearing metals, grease grooving, lubricant application, scale guards, etc., are virtually the same, however, slight variations do appear. What will work well in one mill may be of no particular advantage in another mill on similar applications.

Bearing lubrication has caused concern since the early days when tallow was used extensively. Next followed block grease. Then the automatic lubricating system was installed to pump grease to the grooved bearing surface. Some nine years ago, a lubrication engineer at an Ohio Valley steel plant, designed and put into operation the first blooming mill roll neck spray. Today there are some 20 applications lubricating both metallic and nonmetallic friction bearings. The process of change-over to this lubrication innovation is slow due to production demands on primary mills. Lubricant dispensing equipment and installation costs are small and quickly offset by savings on lubricant, bearing life and downtime. To obtain maximum advantage of spraying fluid lubricants requires close co-operation between the lubricant supplier, equipment supplier and plant engineering and maintenance personnel. The following is the result of that co-operation:

1. Longer bearing life is obtained. Blooming mill roll bearings have been extended from three to eighteen weeks or as much as one set per four roll changes. As to increased bearing life, there are no bearing tonnage figures available—the steel companies are reluctant to give these figures out; however, we do have some data on bearing life based on rolling time in the mills. On one job serving several stands of a Belgium type mill with roll necks of approximately 8 x 10 in., the normal bearing life was three to four weeks. Over a year ago, they installed a roll neck spray system and now have had well over a year's service on the original bearings.

2. Shop work costs are cut. During the past several

Figure 1 — On some applications several spray nozzles may be required. In other cases because of clearance a single nozzle may be used.

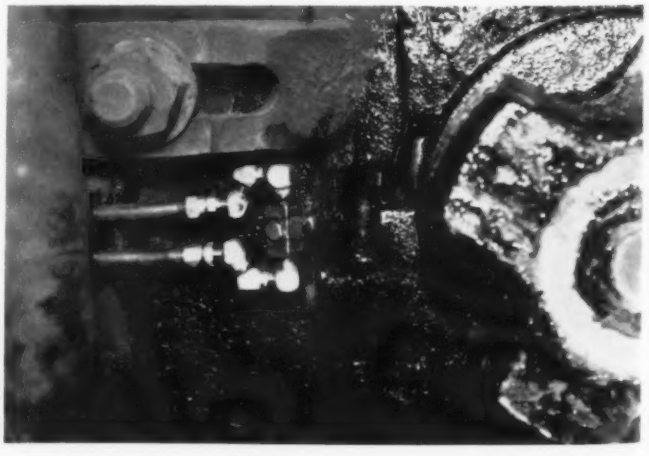


Figure 2 — Air blasts are controlled by the same timer that controls lubricant flow.

Figure 4 — Time clocks can be installed to control lubricant spray of various mills.

years, much study has been given to improving the design of grease grooves. With roll neck spray lubrication, grease grooving is eliminated. Conventional grease grooves become plugged resulting in lubrication and bearing failures. To unplug grease grooves means to change bearings and to change bearings in some cases may require the same time as a roll change which is costly. It takes only five minutes to unplug or change a defective air spray nozzle which can be done without stopping the mill. This is a rare occasion. Not only do you have a dollar savings in machining costs but you increase bearing area for safe loading. In one application on a 46 in. blooming mill, over 90 sq in. in or near the load area of each bearing was lost due to grease grooving. It will help considerably to lengthen the life of these bearings when this valuable bearing surface is put back to work.

Figure 3 — Systems may be set up to operate more than one mill.

3. Roll necks no longer need constant refinishing or dressing. A properly lubricated bearing coupled with a tight fitting scale guard (for blooming and slabbing mill operations) held in place at all times provides additional savings. Scale can ruin a bearing and roll neck in a short time. By keeping this scale problem to a minimum degree, greater bearing and roll neck surface life will be obtained.

4. Mill lining delays are reduced to a minimum. Some mills have downtime costs of from $300 to $1000 per minute on shutdown. Constant bearing changes are costly and can be reduced by roll neck spray lubrication. The right lubricant in the right amount at the right time assures better bearing life.

5. Lubricant consumption is reduced. Some severe blooming and slabbing mill operations have reduced their consumption from one drum per working turn (that represents some 20 drums per week) to three drums per week. Every ounce of lubricant is utilized—spraying some 30 to 50 seconds every 1½ to 2 minutes (this dependent upon the condition and activity of the mill) establishing a film on the journal and bearing surfaces to resist the washing action of the water.

Lubricants have been designed with outstanding characteristics to provide the necessary protection and give longer service to the bearing and roll neck. These lubricants must withstand high pressure water spray, elevated operating temperatures, mill scale contamination and be compounded to a consistency for automatic system operation. These products are of mineral oil base stock supplemented with additives to provide specific properties in the finished product. The product must be versatile in these requirements to lubricate

Figure 5 — Illustration shows bearing to be in good condition after nine months' service.

fabric, bronze, babbitt, segmented or combination.

Bearing clearance is necessary to allow room for free motion between the shaft and the bearing for the formation of an oil film. Good clearance in large bearings such as blooming mills and other mills of large construction should be from 0.060 to 0.090 in.

In a correctly applied or installed bearing, the shaft will flow on a film of oil. This film has a so-called wedge shape, being thicker where the oil is dragged in at the lowest pressure area between the shaft and the bearing; and thinner at the high pressure area. Friction is at a minimum so long as such an oil film is maintained. The oil performs another important function in carrying away excessive heat generated by rolling. Some heat is dissipated through the bearing and its housing. A frequent but small spray of lubricant to the roll neck surface is essential to provide and to retain a permanent film to resist the wiping action and the water washing action. Most wear is on the thrust surface and the spray nozzle is directed to this area or critical point.

On some roll neck applications, dependent on journal length, two or three spray nozzles are required. Where clearance will not permit the installation of the spray nozzles along the parallel surface of the roll neck, then one nozzle is anchored on the outside with the spray directed to the thrust surface. The off-throw of the spray pattern will provide sufficient lubricant to lubricate the journal surface. See Figure 1.

The roll neck spray lubricant has been extended to existing hot sheet mills with excellent results. These mills for years have been lubricated by packing block grease on the journal surface. In one case 10,000 lb of block grease were used each month. Since adopting roll neck spray lubrication with a completely automatic system, the lubricant consumption has been reduced to

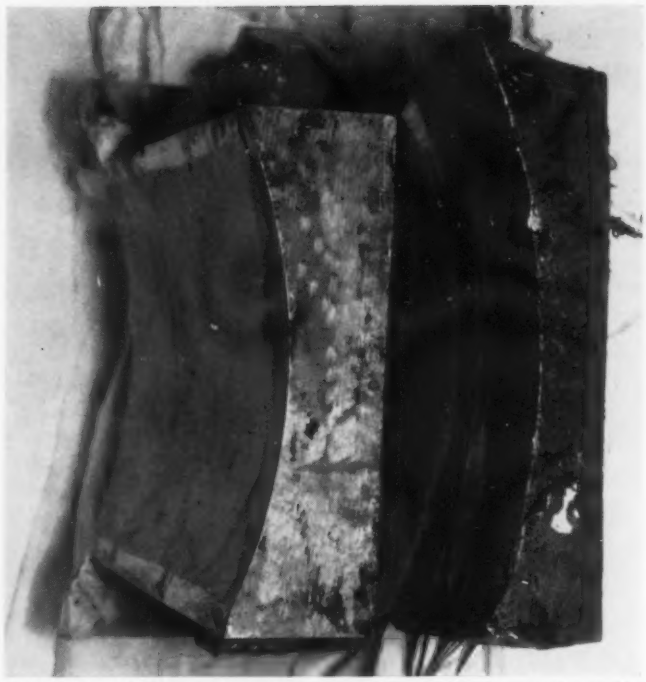
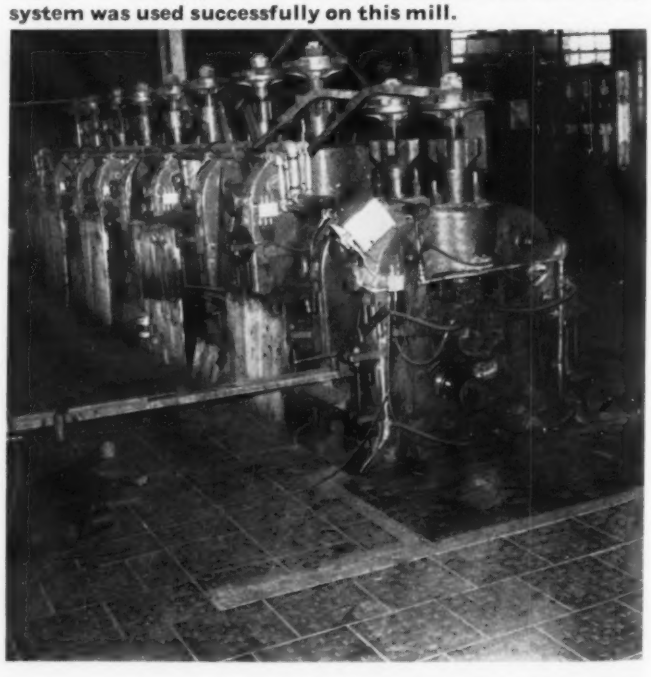


Figure 6 — Illustration shows bearing to be in good condition after nine months' service.

approximately 600 lb per month. When block grease was used as a lubricant it was estimated that more than 80 per cent was wasted by breaking or crumbling from the heat and rolling action, then falling into the pit below the mills. This application has three sprays to each roll neck, spraying the lubricant over the journal surface. The lubricant moves through the spray nozzles under pressure from an electrically powered hydraulic pump. The lubricant sprayed is accompanied by a blast of air going through the spray nozzles. The air blasts are controlled by the same timer that controls the flow of lubricant. See Figure 2.

Through a control channel the lubricant spray can be timed as needed. A frequently-used cycle is for the spray to be applied for a period of 30 seconds and then to be off for an interval of 1½ to 2 minutes. These systems

Figure 7 — A temporary manually operated roll neck spray system was used successfully on this mill.



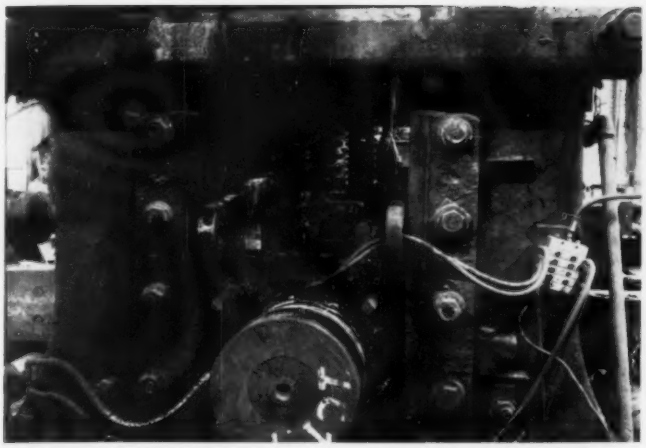


Figure 8 — Installation now in use in many places. The disadvantages of this type of installation are: (1) amount of maintenance required to remove and replace lubricating lines at every roll change; (2) it is very difficult to get and hold a good film of lubricant on the thrust area where it is most vital; (3) the bearings must be grooved reducing load carrying area of the bearing; (4) excessive lubricant consumption; and (5) this type of lubrication requires greater number of lead lines. With the use of spray lubrication, this disadvantage of 24 points can be reduced to four points.

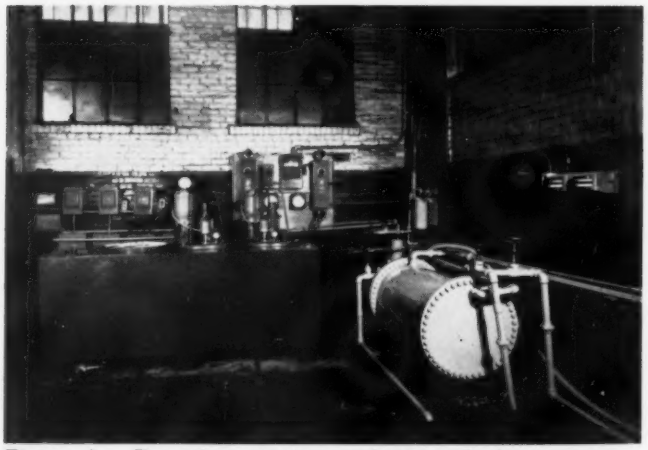


Figure 9 — Pumping station and controls for new type spray system. The tanks have a capacity of 10 drums or two weeks supply of lubricant. Pumps are of electric hydraulic type. Timing for the system is 18 seconds on, 1½ minutes off. This system serves three stands and 32 bearings.

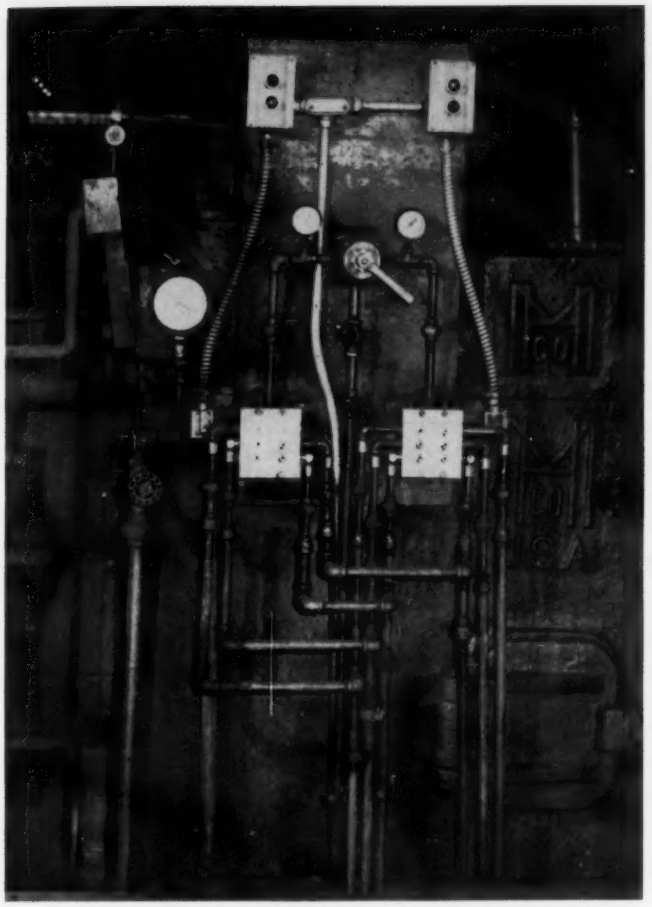


Figure 10 — Valving arrangement shows the method of diverting the flow of lubricant from different stands as needed providing the ability to operate any stand or series of stands depending upon the product being rolled. This type of arrangement makes the system very flexible in operating multiple stands. Regardless of which stand or combination of stands is being lubricated, gages are provided so that any trouble in the system can be determined. Minimum amount of maintenance is required and system is very accessible for inspection.

are designed to operate for either one, two or more mills as required. See Figure 3.

Roll neck temperatures of hot sheet mills have been taken at various locations and there seems to be a wide range. In most instances, however, the temperature ran between 400 and 600 F. The higher the temperature, the more difficult it is to lubricate. Products have been designed to spray on roll necks of these hot sheet mills to withstand such elevated temperatures. A small amount of water is sprayed onto the roll neck which helps the lubrication problem.

On another roll neck spray application, the temperature range was from 550 to 725 F which resulted from the type of metal being rolled. This is a 2-high, 30-in. hot sheet mill with 24-in. diameter necks, 16 in. in length. Bearings are brass. There are a total of eight bearings on the system and replacement of lubricant is estimated at 0.0005 cu in. per minute per bearing per sq in. of surface. This automatic lubricating system consists of a barrel pump with a capacity of four cu in. per minute. This discharge is spread at the central station, half of the pump capacity going to the No. 1 mill and the other half going to the No. 2 mill. Two time clocks have been installed to control the lubricant going to both No. 1 and No. 2 mills. The dials are graduated into seconds so that parts of a minute cycle can be obtained on either mill (Figure 4).

The pump operating pressures are low, between 300 and 400 psi with the mill building temperature approximately 70 F. The pump operates continuously, however, the amount required for lubricant replacement to the bearings will vary depending on the work of the mill. Very rarely does the pump deliver its complete delivery capacity to the bearings. The most used or required cycles are as follows:

a. 30 seconds to bearing feeders; 30 seconds back to drum.
b. 30 seconds to bearing feeders; 60 seconds back to drum.
c. 30 seconds to bearing feeders; 90 seconds back to drum.

Figure 11 — An over-all shot of the merchant mill showing installation of system and piping. Grease and air lines are under the floor plates and feeder valves are mounted on housings. Feeder valves are strategically located for accessibility for inspection and maintenance when required.

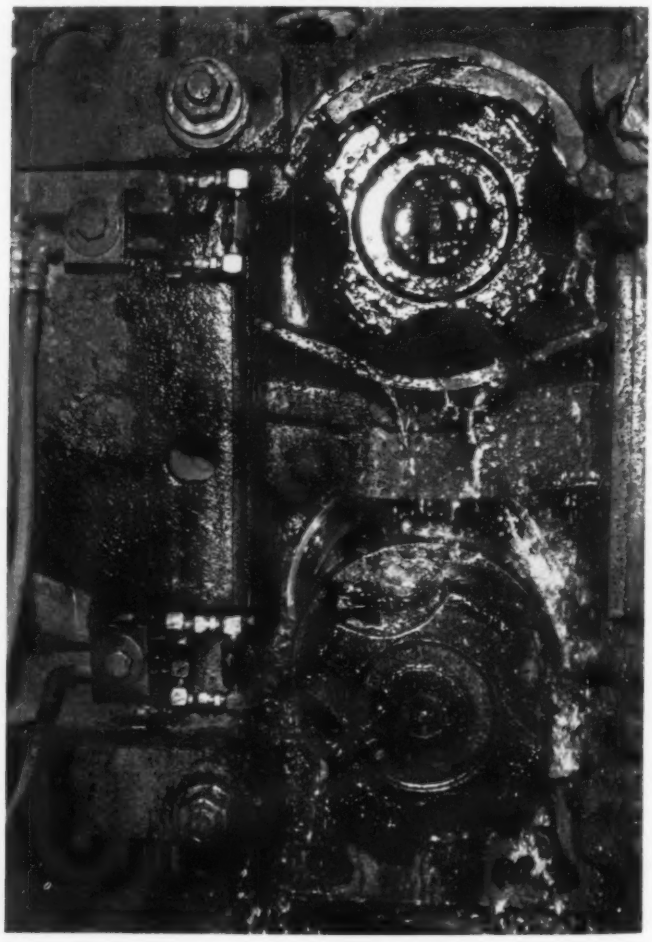
The most desired cycle is 30 seconds on and 30 seconds off. The system operates on this cycle approximately 70 per cent of the time due to the type steel being processed.

Each bearing has three spray nozzles, two on the radial surface and one to the thrust. The radial surface sprays have feeders of 0.050 cu in. each. The feeder to the thrust is 0.100 cu in. or a total capacity of 0.200 cu in. to each bearing per system cycle. With this system the lubricant loss is negligible. After nine months of operation the amount of lubricant in the mill pits is no more than two or three gallons. The bearing dollar savings on this installation is quite large. Under previous operations they would have used some 16 new bearings. During the length of time this roll neck spray system has been used there has been no bearing loss. Bearings were taken from the mills after nine months' service and photographed. See Figures 5 and 6.

A test was conducted on a blooming mill in the Pittsburgh industrial area. We selected what we thought to be the most difficult bearing to lubricate—a bottom roll bearing subjected to all the hazards of mill operation. It was the practice on this mill to change rolls once each week and at this time inspect the bearings as to further service. During this test period one bearing was lost during its fifth week of operation. There were two other test bearings, one with four weeks' service, the other with three weeks. The latter bearings are lubricated with a pressure lubricating system through conventional grease grooving. It is interesting to note the life of these bearings was short. At each roll change the bearing on the opposite end of the roll from the test bearing was completely worn out. Also, several long downtime delays have been charged to leveling up the mill due to bearing wear during the week's operation.

Figure 12 — Closeup of feeder valve, mounting of spray nozzle and Y strainer on header line to feeder block.

Figure 13 — Closeup shows anchoring of spray nozzle. Lubricant on housing is accumulation of six months caused by over-spray and back pressure of nozzle. The nozzle is laying directly into the fillet. Film is on the radius of roll neck where most needed. The air pressure is 25 to 40 psi. The same amount of cooling water is being used as is normally required on a mill of this type.



The interesting point is that during our fifth week of operation with test bearing No. 1, we lost it, but not with the roll neck spray application. Shortly after the start of the week's run we had some subzero temperatures. The temporary lubricating system set up to operate the test nozzles could not develop enough pressure to do so under these cold conditions.

In another test on a continuous bar mill involving a roll neck bearing approximately 8 x 10 in., composition type, water lubricated, the roll neck spray system was applied to one bearing only (the top roll opposite the drive end). Lubricant was supplemented with water to try for longer bearing life and to test the effectiveness of air spray with this type of water application. Results of this test were excellent and have been extended throughout the mill.

Another interesting situation worthy of mention at this time centers around a new merchant mill of seven stands in which the mill builder failed to provide adequate space for the normal applicating of lubricant. A temporary, manually-operated roll neck spray system was installed using a heavy viscous lubricant when this was put into operation. In order to find space for lubricant application, it was necessary to remove the water spray pipes from one side of the roll necks. The results have been good (Figure 7).

All of the pressure type lubricating systems capable of handling heavy lubricants can be adapted to air spray, however, only two have made outstanding progress and each is continuing to improve on its method of control.

Automatic air spraying of lubricants in the industrial field has been found to be very successful in at least two types of applications. Care should be taken not to confuse these methods, as one is for spraying light oils and the other for heavier viscous materials. The first to be developed was for light oils of viscosities from 300

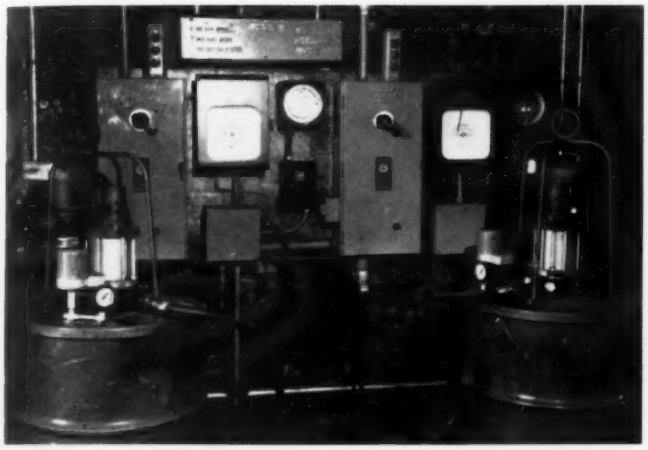


Figure 14 — Another pumping station shows timer, recorder, automatic and manual controls. In this installation, the lubricant is pumped directly from shipping containers as received from the supplier. The pumping cycle is 1 minute on, 3½ minutes off.

Figure 15 — An over-all shot of eight mill stands in this system. Some of these stands have fabric bearings. This system has been in operation for 18 months with excellent results evidenced by savings in bearing and lubricant costs.

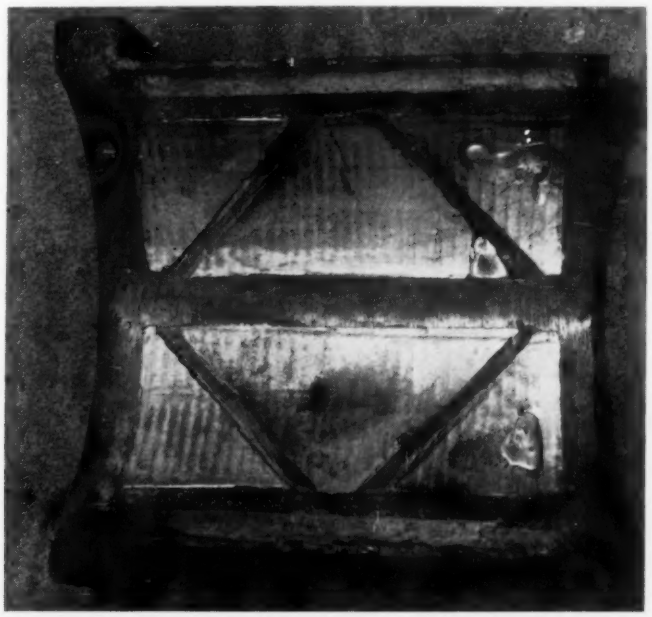
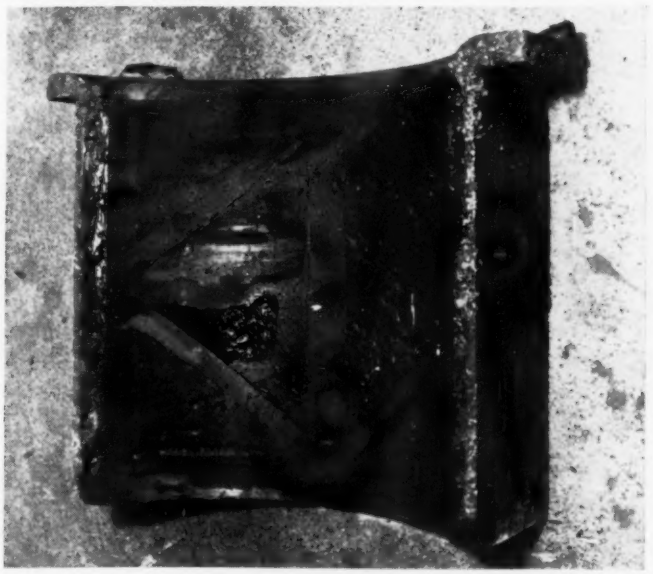


Figure 16 — The type of new bearing being lubricated by roll neck spray lubrication in these systems is babbitt with brass inserts. The grease grooves have been filled to provide increased vital load carrying bearing surface area.

Figure 17 — This bearing was removed from service in the mill after 18 months for photographing purposes. Although the babbitt was wiped, the bearing was still fit for service, however, showed some wear in the thrust area. The remainder of the bearings on this mill tied in with this system are still in service after 24 months. The life of these bearings would have been an average of three weeks before roll neck spray application.



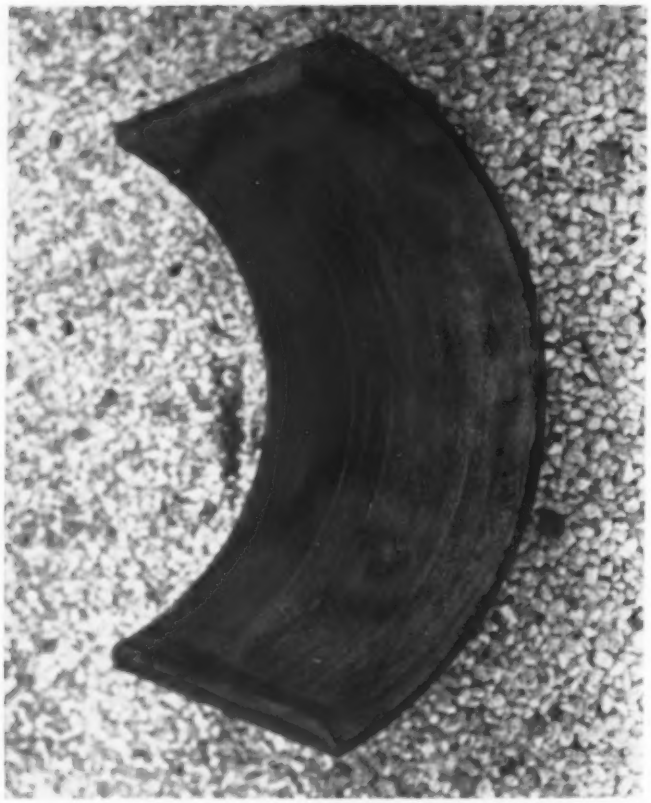


Figure 18 — The type of fabric bearing being lubricated with roll neck spray application is shown in this picture. An evaluation is now being made as to which is more economical: well lubricated brass and babbitt bearings or well lubricated fabric bearings. The study is over one year old and the results are incomplete.

to 750 SSU at 100 F. To my knowledge, the first successful spray application through an automatic device was in the early nineteen-forties. A form of air mist or oil fog was blown through fairly long tubing and drilled passages of a glass bottle blowing machine to successfully lubricate bearings inaccessible by any other form of application.

From this, the device or equipment manufacturers started to concentrate on automatic spraying of heavier materials and successful applications were first made on open and semi-enclosed gears, then to mill journals. Even at this early date some outstanding air spray applications have been reported from steel mills in various parts of the country for roll necks of various types of mills.

The following figures will show pumping station with reservoirs, header blocks, piping and actual spraying on blooming, billet, bar and hot sheet mills.

Discussion

PRESENTED BY

WAYNE G. RITTER, Ritter Engineering Co., Pittsburgh, Pa.

E. J. GESDORF, Senior Application Engineer, The Farval Corp., Cleveland, Ohio

Wayne G. Ritter: The roll neck spray systems, as described by the authors of this paper, have been generally successful. As designers and suppliers of systems for the spraying of roll necks, we would like to summarize briefly some of the principle advantages and disadvantages of this method of applying lubricants:

Advantages

1. More available bearing area because of absence of grooves.
2. More adequately lubricates bearing thrust surfaces
3. System not susceptible to plugging because of closing of grease entry ports caused by bearing metal flow.
4. Systems are simpler—less lubricant entry ports into bearing.
5. Possibly less lubricant consumption depending upon particular design.
6. Longer bearing life obtainable.
7. Less scoring of roll necks.

Disadvantages

1. No reservoir of grease in bearing grooves to provide a factor of safety in case of stoppage of lubricant flow.
2. Exposed spray headers susceptible to breakage during roll changes.
3. Susceptible to changing spray patterns as effected by lubricant viscosity.
4. Smaller range of greases available which have characteristic of adhesiveness necessary for successful application.
5. Air supply is critical—and expensive.

E. J. Gesdorf: We have followed these developments with interest and enthusiasm and have had first hand experience on a number of installations. If you are interested in spray lubrication for roll neck bearings there are several important points to consider and carefully evaluate, such as:

a. Are capable technicians available to install, operate and maintain a roll neck spray system in your plant?
b. Is this to be a conversion from block grease lubrication to spray lubrication?
c. Is this to be a conversion from the grease groove pressure injection method to spray lubrication?

A few brief comments on these points will be sufficient at this time.

It should be clearly understood that the installation, adjustment and maintenance of a roll neck spray system is considerably more complex and time consuming than is the comparable attention required by a conventional centralized lubricating system. This is due principally to the fact that additional elements, namely air pressure and nozzles, are introduced and the equipment must be located in a vulnerable area as far as roll changes are concerned. As time goes on, the design and installation techniques may progress to a point where these problems can be eliminated. However, our own experience to date is that the knowledge acquired on one installation does not readily apply to the next installation. Each installation must be tailored to suit the exact conditions in the field.

The authors have demonstrated some of the phenomenal results achieved by spraying roll necks with high quality extreme pressure gear oils. We believe that a sizable amount of this knowledge relates to conversion

from block grease lubrication to spray lubrication. Our experience verifies the facts presented to you on this type of conversion. Where a mill has been designed and operated on block grease, the simplest, cheapest and quickest road to improved bearing performance at lower cost is by spray lubrication. This can be accomplished without any bearing design changes. The secret of success in spray lubrication of roll neck bearings is closely related to the quality of the lubricant used.

We have been watching and studying the second type of conversion mentioned here—converting from the grease groove pressure injection method to spray lubrication. It is indeed unfortunate that tonnage figures were not given today, for as we see it, this is the only available basis for accurate comparison and evaluation of achievements. In the February 1958 issue of the *Iron & Steel Engineer*, George Sackerson of the Bethlehem Steel Co. gave in his paper "Primary Roll Neck Bearings and Their Protection" the full story on roll neck bearing performance with the grease groove pressure injection method of lubrication. Included in his paper were tonnage figures as well as lubricant consumption, water consumption and bearing design.

If Mr. Sackerson's reported consistent roll neck bearing life of a million to a million and a half tons of steel rolled is to be our yardstick then we still have some work to do with roll neck spray lubrication on the larger mills. The only performance data that we have in connection with spraying roll necks on a large mill has been on a 46-in. blooming mill. This mill was converted from the grease groove pressure injection method of lubrication to spray lubrication. As a result of this change, bearing life was increased from 64,000 tons to 138,000 tons, the roll necks maintained good condition with no pitting or fire cracking, delays for mill alinement were eliminated. However, accompanying this change was a sharp increase in the lubricant cost for the mill resulting from the use of a higher priced lubricant and increased lubricant consumption. Apparently the advantages of spray lubrication on this mill have more than offset any disadvantages as there is no indication of a desire to return to the original method of lubrication.

Sugar mill roll neck bearings have been efficiently and economically lubricated with extreme pressure gear oil injected into the grooving. As far as we know, this approach has not been evaluated for steel mill roll neck bearings as we have no knowledge of existing data. ▲

Available Translations

As a service to readers of the Iron and Steel Engineer a list of translations from foreign articles is being printed intermittently. Articles selected for this listing will be those thought to be of primary interest to the American steel plant operator. The papers may be obtained from the Cooperative Translation Service, The Iron and Steel Institute, 4 Grosvenor Gardens, London, S. W. 1, England. All correspondence concerning price, ordering, and so forth should be directed to that address.

1245 EICKEN, H., and W. HEIDENHAIN: "The Effect of Drawing Speed, Reduction in Cross Section and Carbon Content on the Mechanical Properties of Drawn Steel Wires: Power Requirement in Drawing," *Stahl u. Eisen*, 1924, Dec. 18, pp. 1687–1694. (Abstract J.I.S.I., 1925, vol. 111, pp. 569–570: The influence of speed of drawing on steel wires containing 0.26 per cent and 0.83 per cent of carbon is investigated and the results are shown in tabular form and in diagrams. One set of tests was made in which the reduction was 15 per cent per draught, a 5-millimetre wire being drawn down to 2.7 millimetres in eight drawings. A second set was made with a reduction of 25 per cent per draught, and a third set with a reduction of 35 per cent per draught. In the first tests the lower carbon wire increased in tensile strength from 85 to 100 kg. per mm.^{2} and the high carbon wire from 146 to 180 kg per mm.^{2} With the greater reductions per draught and the same speed of drawing (1.40 metre per second) the tensile strength increased to 136 and 215 kg per mm.^{2} respectively.)

1250 ROSANOW, W. B.: "Experimental Investigation of Pump Drive without Accumulators for Hydraulic Presses," from the German translation of the Russian book "Hydraulic Presses," edited by A. I. Simin, pp. 130–141. (Abstract: A study of a 3000-ton press powered by rotary pumps was made and measurements were made with devices, and using the circuits, described to calculate power consumption and the dynamic properties of the press throughout the working cycle. A load cell for use in the oil pressure system, and a single phase loop power consumption meter as well as an inertialess stroke recorder are described.)

1275 DAHL, W., and W. LUEG: "Study of the Effect of the Rolling Conditions on the Properties of Hot-rolled Low Carbon Steel Strip," II—"Mechanical Properties and Structure." *Stahl u. Eisen*, 1958, Dec. 11, pp. 1793–1798. (Abstract: The authors present the results of an investigation carried out to determine the effect of hot and cold working on the mechanical properties and structure of low carbon steel strip. Cold rolling was carried out on both an experimental and industrial rolling mill. Relationships between rolling temperature and tensile strength and between cooling rate and structure are discussed.)

1276 SCHMITT-THOMAS, K. G., et al.: "The Effect of Carbon Content, Cold Working and Heat-treatment on the Properties of Aluminium Killed Deep Drawing Steel Strip," *Stahl u. Eisen*, 1958, Dec. 11, pp. 1798–1808. (Abstract: The results of a study to determine the effect of carbon content and cold working on the mechanical properties of deep drawing steel strip are given. In this study the steel strip was subjected to various annealing conditions. The effect of preliminary treatment on the behavior of the strip during temper rolling and the effect of coiling temperature are also discussed. The results are evaluated by applying the dislocation theory. Micrographs and curves showing relationships between the variables are presented.)

AUTOMATIC

AMONG the many problems confronting the producer of hot-rolled strip product is the production of a hot-band with a uniform thickness and width pattern. For this reason, continuous improvements are being made to rolling facilities and controls to provide a more accurate setup and maintenance of mill settings during rolling. Increased interest has been shown during the past few years in the control of product thickness by automatic means. Extensive studies and applications of automatic control equipment for tandem cold mills have been made. The application of automatic thickness control equipment to existing hot-strip mill finishing stands, however, has not yet gained the same wide interest. This is probably due to the increased complexity of possible control equipment and the substantial costs associated with large scale mill modifications. Expenditures for control equipment of this type have to be in sound economic relationship to the attainable results.

The application of automatic thickness control to the Geneva hot-strip mill finishing stands is the result of a series of developments which have taken place during the last few years. The application is the logical climax to a series of mill additions and modifications, since the construction of the plant during 1942–43 as a 132-in. semi-continuous plate mill. During 1948, the mill was altered and facilities, including two additional finishing stands, were installed to permit the production of hot-rolled strip coils allowing, at the same time, continuation of plate production. In 1955, speed regulators were installed for the six finishing stands, and a width gage was installed in connection with a width control program. During 1956, taper-tension control equipment was placed into operation to reduce the trailing-end thickness increase which is common in hot strip. These developments are mentioned since each contributed to the understanding of the problems and possible solutions to automatic thickness control.

Commercial tolerances established for hot-rolled strip do not necessarily reflect the desired objective in reducing thickness variations within the body of the strip coil or from coil to coil. Variations in thickness from the hot-strip mill are also reflected in cold-rolled strip and cause difficulties during further processing in electrolytic tinning lines, galvanizing lines and customer punch and die lines. The ideal objective is to produce a uniform thickness from head to trailing-end at the hot-strip mill and subsequently achieve improvements and increased accuracies through the cold reduction facilities. There also has been a recurring demand for improved thickness performance on hot-rolled sheet products. Any facility that will contribute to more uniform thickness performance will definitely improve the competitive position of a strip producer.

The automatic thickness control system installed at Geneva Works is the result of over three years of engineering investigation. It is important from an engineering viewpoint that the development and the limitations of the control equipment are fully understood. A detailed study of the problems peculiar to hot-strip mills had to precede any possible applications of automatic thickness control equipment.

Some examples of variables which were qualitatively known before the tests are:

1. Temperature is a hot-mill variable which results in finished thickness variations. This, of course, is obvious from the observance of skidmarks, hot and cold (relatively) slabs and the gradual increase in finished thickness due to the differential temperature of a slab from head-end to trailing-end.
2. Tension changes during rolling result in thickness variations. It can be observed that as the strip leaves successive stands, finished thickness will increase in a stepped pattern, the degree of which is a function of the interstand tension which existed during rolling.
3. The obvious effects of roll opening.
4. The obvious effects of chemical analysis.

The test results were important in settling differences

Figure 1 — Charts show hot strip mill thickness variations due to temperature.

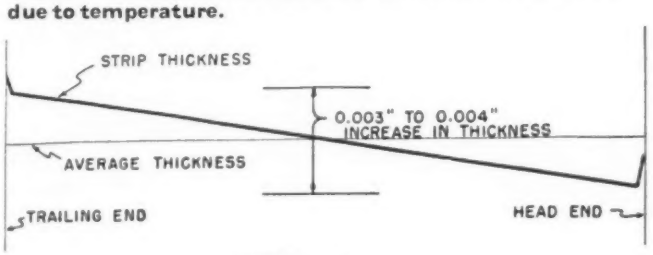


FIGURE 1A

THICKNESS VARIATION DUE TO LOSS OF TEMPERATURE FROM HEAD END TO TRAILING END

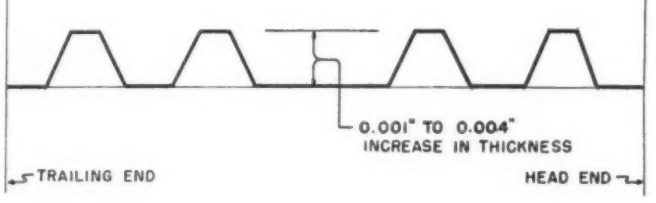


FIGURE 1B

THICKNESS VARIATION DUE TO SKID MARKS

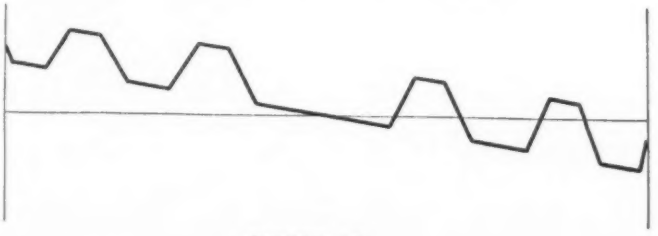


FIGURE 1C

THICKNESS VARIATIONS FROM HEAD END TO TRAILING END DUE TO TEMPERATURE VARIATIONS

THICKNESS CONTROL—

Geneva Works Hot Strip Mill

By LOUIS E. RINGGER,
Assistant Works Engineer
and GEORGE S. KOSS,
Assistant Division Superintendent
Rolling Mills,
Geneva Works,
Columbia-Geneva Steel Div.
United States Steel Corp.
Provo, Utah

Geneva Works has for some time been blazing the trail down which will follow advocates of automatic gage control for hot strip mills

of opinions, formed from the abnormal conditions which sometimes occur.

The problem of thickness control can be reduced into simple component parts. Referring to Figure 1, Figure 1A shows the finished thickness increase due to the loss of strip-slab temperature from head-end to trailing-end and which varies to about 0.004 in. or about five per cent of a typical 0.074 in. thick strip coil. Figure 1B shows the variation in finished thickness due to reheat furnace skidmarks and which varies from a negligible amount to about 0.004 in. Figure 1C shows the composite result of the variations which are due to temperature alone. Referring to Figure 2, Figure 2A shows the approximate variation in thickness which is caused by interstand tension required for rolling strip and which varies to about 0.005 in. at the trailing end. Figure 2B shows the composite results of temperature variations and interstand tension. The range of thickness variations indicated will vary with the mill setup, mill conditions and product dimensions.

To these variations must be added those which occur from slab to slab which are caused by other hot-strip-mill variables such as differences in reheat furnace temperatures and differences in width and thickness. It was found that finished strip thickness variations within a single coil were largely a temperature problem.

A great variety of approaches have been suggested by parties interested in the thickness control problem, some of which are:

1. Control the variables which cause variations at their source, e.g., control reheat furnaces to eliminate skidmarks or temperature differences from slab to slab.
2. Compensate for the effects of the variables by use of screwdowns or by controlling tension.
3. Control thickness by screwdown control or tension control on one or more of the finishing stands.
4. Control thickness to constant value from coil to coil or only to a constant value within one coil and accept thickness variations due to temperature variations from slab to slab.

The theory of automatic thickness control for rolling mills has been discussed in many outstanding papers. Aspects associated with hot-strip mills have been published in the May, 1958, *Iron and Steel Engineer* (1).* Before reviewing an actual application, however, a brief review of the physics of the rolling process is desirable. Strip is made to flow plastically as it passes between the work rolls. If, in addition, tension is applied to either side of the roll gap, the roll pressure required will decrease, since plastic flow theory states that the vertical compressive stress plus the longitudinal ten-

Figure 2 — Chart shows hot strip mill thickness variations due to temperature and tension.

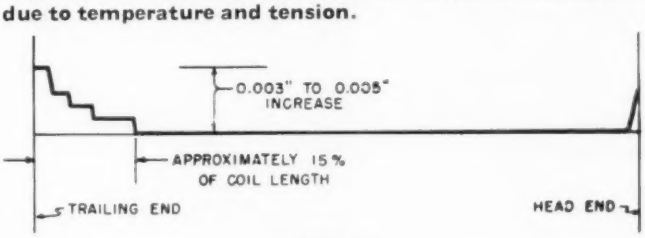


FIGURE 2A
THICKNESS INCREASE DUE TO INTERSTAND TENSION EFFECTS

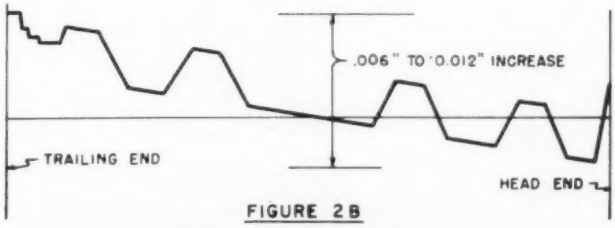


FIGURE 2B
THICKNESS VARIATIONS DUE TO TEMPERATURE & TENSION

* Numbers refer to Bibliography at end of paper.

sile stress must equal the yield stress at every point in the roll gap. The rolls and the mill housing act like a large spring and tests show that the combination follows Hooke's law in the working range (2): that is, there is a linear relationship between the change in work roll force and change in work roll opening. Therefore, when tension is applied to the strip on either the entry or the exit side of the roll gap, the roll pressure decreases and the work rolls move closer together until a new point of equilibrium is reached. The delivered thickness can be decreased by increasing incoming or outgoing tensions or by increasing roll pressure through a screw position change. Thus, thickness controlling means must use one or both of these methods in one or more stands of the mill.

R. A. Phillips has demonstrated (1) it can be expected that a regulating system to compensate for strip temperature variations introduced to the finishing train will be more than adequate to compensate for the strip thickness variations introduced. Physically, there are but two ways to minimize the effect on strip thickness variations caused by temperature variations. One choice is to eliminate the cause by reducing the temperature variations from slab to slab and within a slab. The second choice is to use thickness regulators reacting to changes in thickness or roll force.

Temperature variations appear to the mill as hardness variations. If the mill were absolutely stiff, these hardness variations would produce no thickness variations. It could then be assumed that no interstand tension variations would be produced by the theoretically stiff mill. Such a mill should then roll strip of uniform thickness and width. The question arises, can a stiff mill be realized in practice? As a definition, a stiff mill stand is one in which a change in roll force due to a hardness variation or incoming thickness variation produces no change in work roll separation. From a mechanical design standpoint such a mill is impractical, but considering the mill as an electromechanical system, this concept is possible.

The work of R. B. Sims (2) and others have led to a system of automatic thickness control which is based on the concept of a stiff mill. This stiff mill concept states that if there were no housing and roll deformation or roll flattening during rolling then the exit thickness of a stand would be an independent variable varying only with the screwdown setting. A regulator acting quickly to change the roll opening of a stand to hold constant thickness delivered from that stand would satisfy the stiff mill requisites. If less than all of the stands of a multi-stand mill are made stiff in this manner, some of the interstand tensions will vary. These tension variations can be minimized by quickly varying the appropriate stand speeds. It should be remembered that changes in interstand tension will produce changes in strip thickness.

Before thickness can be controlled, the thickness must be measured or the variations detected. Furthermore, this must be done instantaneously so that mill correction may be applied at the proper time to compensate for thickness variations. One method utilizes the fact that the mill housing and rolls deform elastically under load proportional to the applied load and the mill modulus. Electrical quantities representing this deformation, or mill spring, together with an indication of the unloaded screw setting are combined to indicate strip thickness at the rolls. Roll separating force is measured by use of load cells installed on the mill. This method of thickness measurment is known as a gage meter and since it measures at the roll gap, it gives an instantaneous indication of absolute thickness in the roll gap. Unfortunately, the gage meter alone does not recognize certain factors such as changes in temperature of mill rolls and roll wear. However, it may be

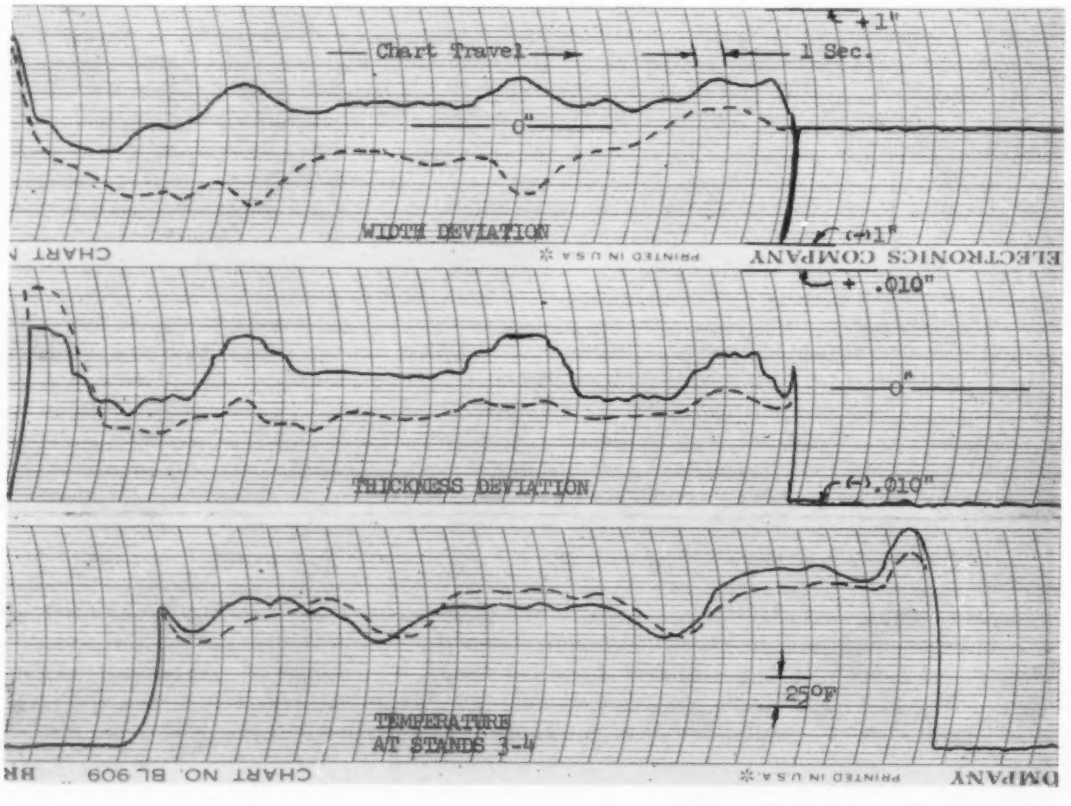


Figure 3 — Temperature effect on strip thickness and width. Solid lines show uncorrected pattern. Dotted lines show pattern with manually applied tension correction.

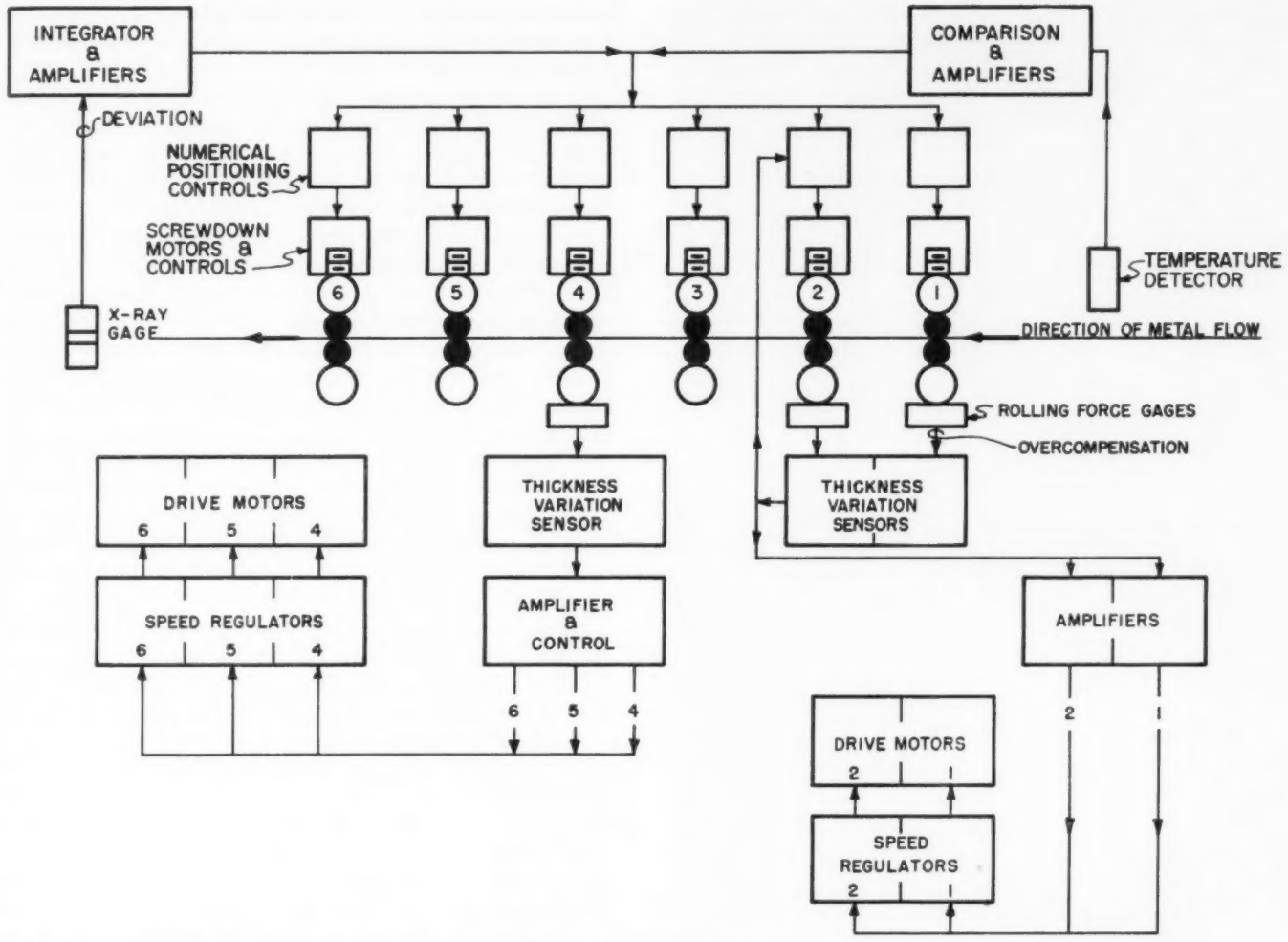


Figure 4 — Simplified diagram of automatic thickness control functions.

recalibrated continuously by means of a thickness gage located immediately after the mill stand. By use of a load cell as a roll separating force detector and controlling screwdown position to maintain constant roll opening, an absolute system of automatic thickness control can be obtained such that a mill stand delivers a constant preselected thickness.

The merits of this system for a single-stand mill are well recognized. No attempt has thus far been made to apply it to a multi-stand hot-strip mill due to the major expenditures which would be required to modify stand screws for high speed of operation and accuracy and due to the somewhat complex interaction of mill stands.

Recognizing the importance of measuring strip thickness at the roll gap and the fact that some of the thickness changes occur gradually along the body of a strip-slab, a control system has been selected using a combination of screw position and interstand tension controls which obtain their signal from load cells installed on the mill. This latter type of control is capable of fast vernier action correcting for rapid changes in thickness and leaving the correction for gradual changes to the screws. In order that the vernier not be required to exceed the small tension range permitted in hot-strip-rolling which will cause necking down of the strip, the screw position regulating action is supplied at the entry end of the finishing stands.

In 1956, tests were made on a manual basis to verify the expected results of such an automatic thickness control system. Results of the tests indicated that the system then proposed was practical and flexible. The analysis of thickness variations as a function of temperature and tension is supported by experimental work done at Geneva Works by the Research Department of United States Steel Corporation. The test results, a part of which are shown in Figure 3, show clearly the pattern of thickness changes due to temperature along the body of the strip-slab, and the sharp changes of the head-end and trailing-end thickness as tension is applied to and removed from the strip. In addition to these results, fundamental proof was obtained that tension could be used on a production mill as a thickness controlling means without detrimental effects to width.

The solid lines in Figure 3 show a thickness, width and temperature pattern in which skidmarks are unusually severe. The strip-slab shown with the solid lines had no correction applied. The dotted line in Figure 3 represents the succeeding slab from the same reheating furnace to which manually-applied tension adjustment was made. The manual adjustment was made in response to visual observation of the skidmarks as they passed through the mill. The curves show that the manually-applied tension was not correctly timed and was excessive. These particular conditions, however, allowed substantial improvement in thickness performance for the manually corrected slab with moderately severe effects to width. These tests also demon-

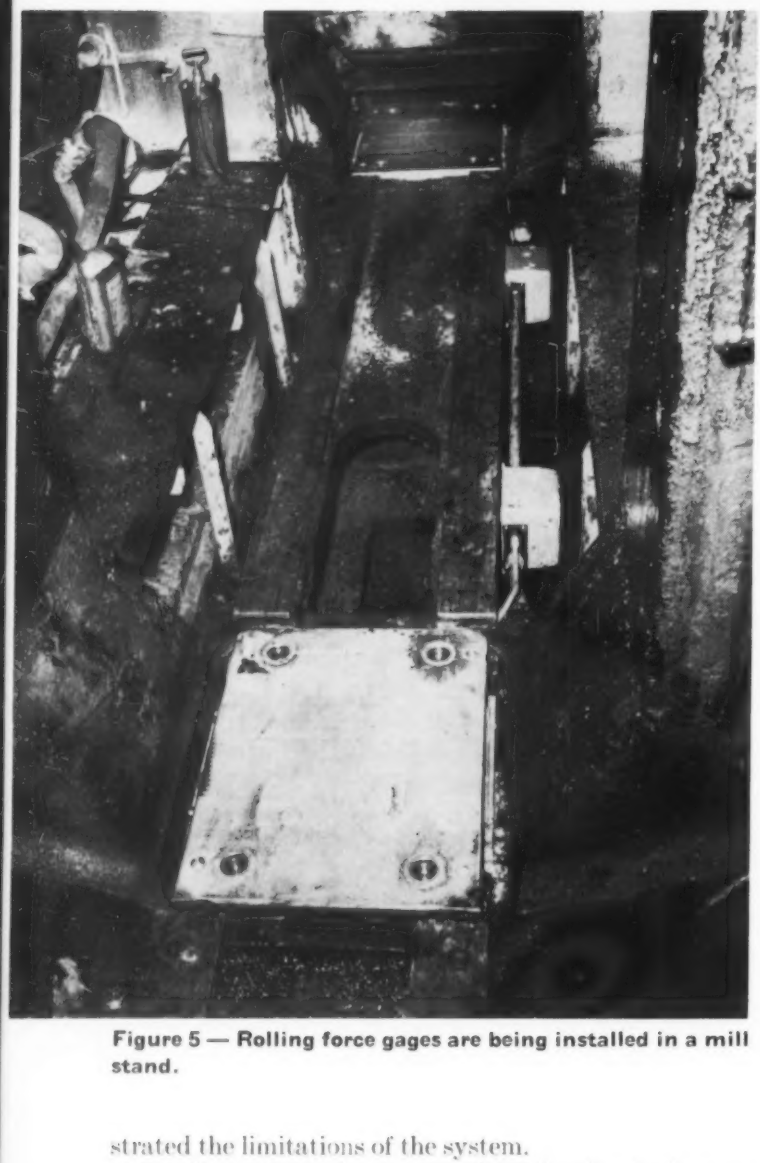


Figure 5 — Rolling force gages are being installed in a mill stand.

strated the limitations of the system.

On the basis of these tests the following basic concepts for the Geneva hot-strip mill thickness control system were established:

1. Screwdown control at stand 2 to make continuous adjustment to stand 2 screws as a function of rolling force at stand 2 modified by an over-riding signal from stand 1 rolling force. The primary purpose of this portion of the system is to correct for large over-all increases in thickness along the length of a slab due to loss of heat during the finishing process, thereby avoiding width problems and keeping speed-tension changes in the latter stands within a smaller range.

Screw movements should be accompanied by speed changes to maintain essentially constant tension between stands 1 and 2, and 2 and 3. Screw adjustments should also decrease the magnitude of thickness changes at skidmarks: however, it is expected that screwdown motor torque and speed without extensive modifications to the system would somewhat limit the effective use of the screws on fast changes. Also, the amount of "reset" time between slabs would be a limiting factor during maximum rolling effort.

2. Speed-tension control at stands 4, 5 and 6 would maintain essentially constant finished thickness. Tests indicated that a closed-loop system which maintains constant rolling force at stand 4 or 5 would be a practical approach to thickness control by tension. Moderate tension applied would have no adverse effect on strip width. For the correction of variations within a strip-slab, the control signals should be derived from a load cell installed at stand 4 or stand 5 in order that transport time-lag does not cause correction signals which are too late or too early. A signal from an exit thickness gage is not desirable for this purpose.

3. Screwdown adjustments at the latter stands will only be made between slabs to bring delivery thickness within desired range. Screw adjustments at stand 6 are normally made by the operator to control shape of the finished product. Reductions at stand 6 are normally small (5 to 15 per cent) which means that large percentage changes in rolling force would have to be continually made to control finished thickness. Work rolls may be set "below face" at the latter stands. Under these circumstances, large changes in screw position requiring considerable power would be necessary to accomplish a comparatively small change in finished thickness. This would require extensive modifications to the mill.

These tests were possible and successful because of the previous installation of the finishing stand speed regulators. The installation of speed regulators is prerequisite as the first step toward automatic thickness control. The fundamental contributions to hot-strip-mill control at Geneva Works are, therefore, the application of speed regulation to the mill in an effort to reduce the effects of transient tensions and to hold a more consistent tension, and the realization that moderate tension may be applied to hot strip without necessarily causing it to neck down. Whether or not strip will neck down on applying tension will depend on the magnitude and time interval of the applied stress.

The system that Geneva elected to install is shown in simplified schematic form in Figure 4. Rather than regulate thickness to an absolute reference which, in a continuous mill, would require extensive precautions to isolate stands from each other so that interaction would not occur between adjacent stands, a system was selected which establishes an individual thickness reference for each slab. The fact that the finished thickness of a strip-slab is, as a rule, increasing from head to trailing-end allowed the use of the head-end of each slab as a new thickness reference. Thickness correction may then be made by either increasing tension on the strip or by moving the screws in a downward direction. To control thickness within a close tolerance band, additional control functions are required:

1. Speed regulators had been installed on all finishing stands in 1955. Regulators allow for accurate setting of stand speeds independent of load.

2. Numerical positioning controls are required for screws. The use of screws for regulating purposes requires accurate means for positioning and resetting in accordance with control impulses. All screws have, therefore, been equipped with numerical positioning control equipment which is used for initial setup of mill-stands and for thickness control functions. Unloaded roll openings are positioned repetitively within plus and minus one mil. The roll setting is accomplished by decade pushbuttons.

3. Stand 2 screwdown regulation of thickness delivered from stand 2 with a provision of over-com-

pensation is desirable. This is a comparatively slow response system and is used to compensate for comparatively slow thickness changes. A load cell on stand 2 senses thickness variations, using head-end rolling force as a reference, as they occur and causes the screws of stand 2 to be adjusted.

The required screw movement is obtained by injecting a voltage signal into the numerical positioning control system. Deviations exceeding a preset value which require a change in speed will cause magnetic amplifiers in the speed regulating circuits of stands 1 and 2 to produce proportional speed changes. The speed change/signal change ratio is preselected and may be adjusted independently for each of the two stands.

One of the characteristics of the finishing stands is that a thickness variation due to temperature, if corrected in the entry end, would grow back in at the later stands. For example, if the variations were corrected in stand 1 only, approximately 65 per cent of the variation would still appear in finished thickness. For this reason, a load cell on stand 1 senses thickness variations and provides an over-compensation signal for the screws of stand 2.

4. Tension regulation of exit thickness variations is accomplished by increasing speed of stands 4, 5 and 6 controlled from a rolling force signal derived from stand 4. Load cells under the bottom backup rolls of stand 4 measure the roll separating force. The rolling force existing at the time the head-end enters stand 6 becomes a reference for roll force deviation.

Deviations of any magnitude in the direction of an increase in rolling force cause magnetic amplifiers in the speed regulating circuits of stands 4, 5 and 6 to produce a proportional speed increase.

Figure 6 — A calibration curve for 1600-metric ton load cell.

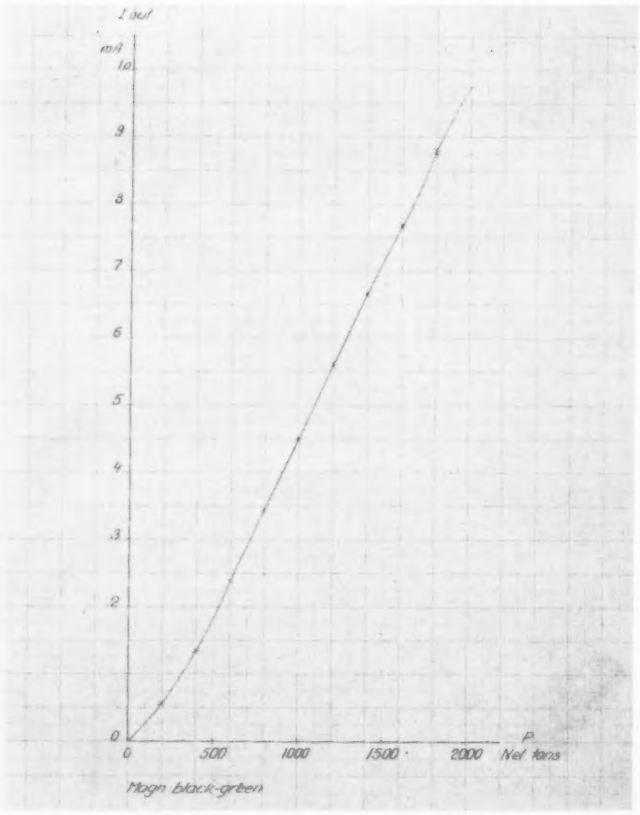


Figure 7 — Screwdown for speed controls are arranged for convenient operation.

The speed change/signal change ratio is preselected and may be adjusted independently for each of the three stands.

Circuits are provided which limit any speed increase to 10 per cent and limit maximum speeds to values below the correct settings of stand motor over-speed trip devices.

A rolling force decrease with respect to head-end value (negative deviation) will cause no speed change, thereby avoiding speed changes which can cause loss of tension or looping between stands.

As an alternate arrangement, load cells under the bottom backup rolls of stand 5 may be connected in place of those of stand 4. Rolling force deviations will simultaneously cause speed changes in stands 5 and 6 or alternately in stand 6 only.

5. Bar level temperature compensation is provided. To maintain strip to strip thickness within a close tolerance envelope, the average level of slab temperature entering the finishing stands is considered. Differences between reheating furnace temperatures will result in thickness variations from slab to slab. Normally these variations are of small magnitude. The control measures the temperature at a fixed distance from the head-end of the slab before it enters the finishing stands. The temperature is then compared with a reference temperature. Temperatures within 20 degrees F of the reference value cause no changes to roll openings. Temperatures greater or less by 20 to 40 degrees F cause screws of all stands to move up or down by one temperature correction increment. Nominal values for temperature correction increments are preset by the operator and may be adjusted as desired for each stand. Screws of stand 1 through 6 move in sequence, beginning with stand 1, as the trailing-end of the preceding strip leaves each stand. The required screw movements are obtained by injecting voltages into the numerical positioning control system.

6. Mill drift compensation control integrates the

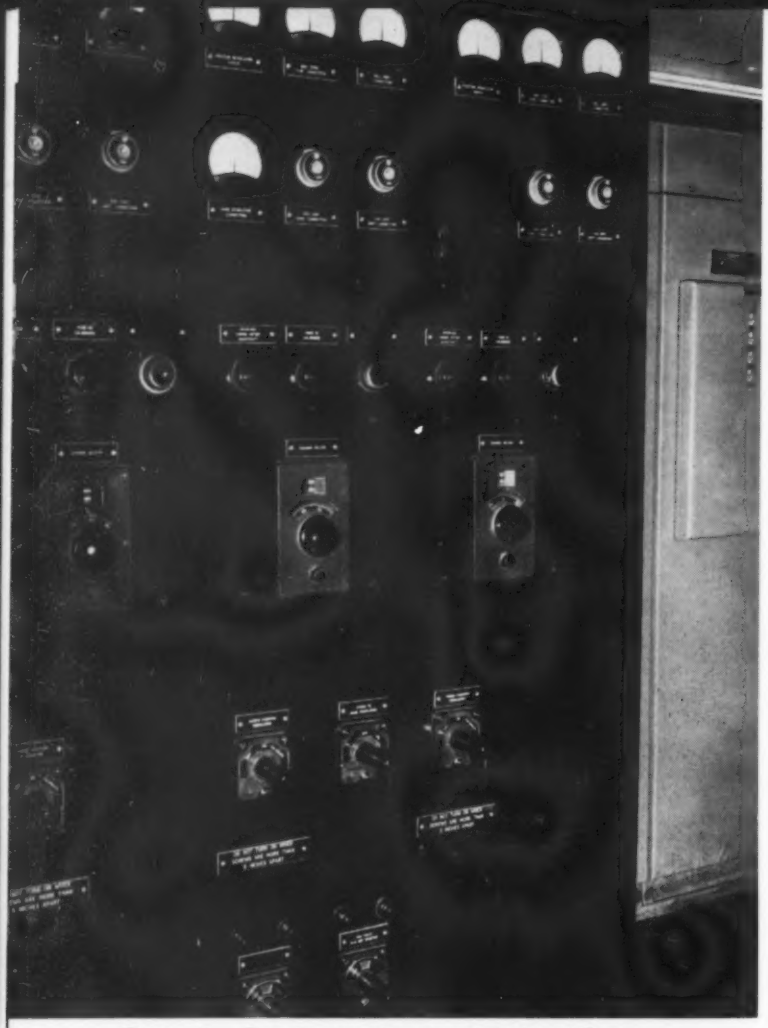


Figure 8 — Panel set up for stands 1, 2 and 3.

delivered thickness of the strip through the use of the exit x-ray thickness gage. If the average thickness is outside a preselected tolerance, then the screws are adjusted. This control has as its purpose the monitoring of the manual settings of screw position.

If the average deviation over the portion of the strip measured exceeds a preset minimum, screws of stands 1 through 6 move in sequence, beginning with stand 1, as the trailing-end of the strip being measured leaves each stand.

The required screw movements are obtained by injecting a voltage signal into the numerical positioning control system. When this signal occurs simultaneously with other injected signals, the resulting screw movement corresponds to the net signal. The drift compensation will change in magnitude (and can change in direction) when thickness exceeds plus or minus preset minimum values.

The control equipment was installed during July, 1958. Equipment tune-up was required before the equipment could be rendered operational. During December, 1958, operator familiarization was completed and continuous operation of the automatic control system was started.

It will be of interest to explain briefly the techniques and equipment which were used in making up the automatic thickness control installation. Load cells at Geneva, mentioned previously, are load measuring devices manufactured in Sweden. The units used measure approximately 34 x 16 x 3 in. and are rated at 1600 metric tons each. Roll force measuring devices used on other mills are either mounted on the mill housing, as strain gages, or between top backup roll

Figure 9 — Thickness and width patterns for 0.074 x 34⅝ in. strip shows product improvement with regulator.

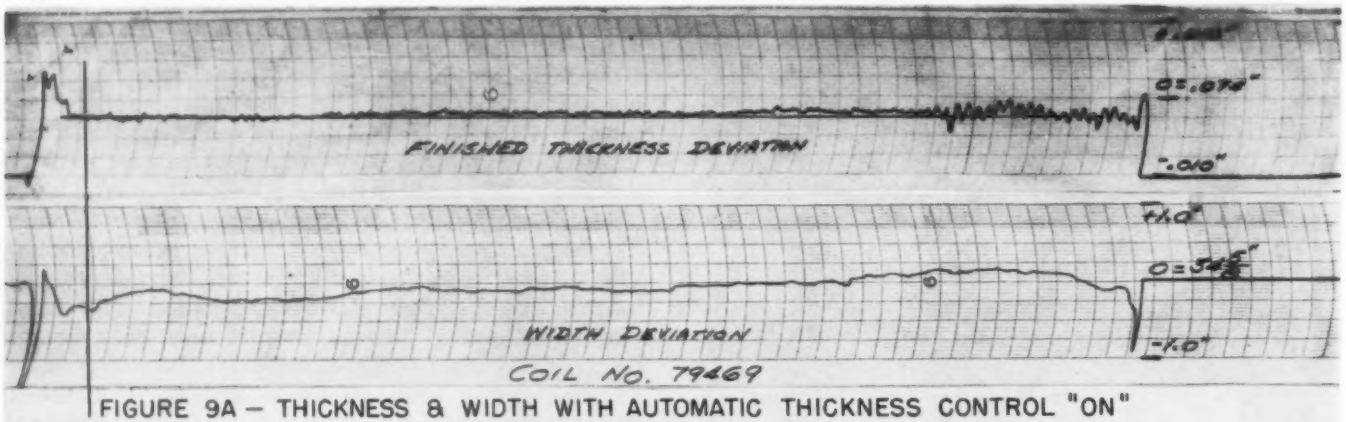


FIGURE 9A — THICKNESS & WIDTH WITH AUTOMATIC THICKNESS CONTROL "ON"

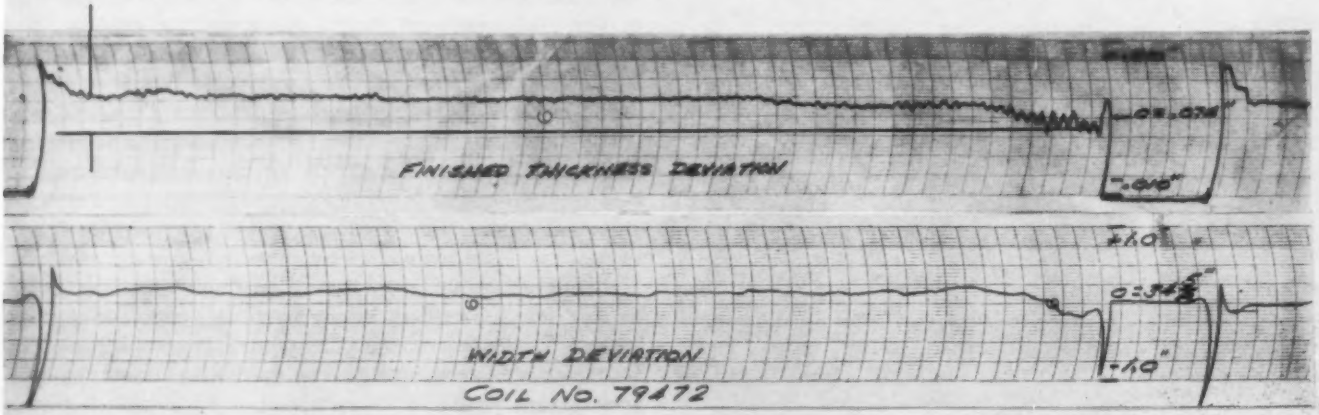


FIGURE 9B — THICKNESS & WIDTH WITH AUTOMATIC THICKNESS CONTROL "OFF"

bearing chocks and the screws. These load cells were installed below the roll changing sled in the individual mill housings due to their ruggedness and physical dimensions. One of the main advantages of this approach is that no electrical connections have to be made during the changing of rolls and the cells can be fully protected from external damage.

For reasons other than strictly automatic thickness control, the load cells are placed in all of the finishing stands. Rolling force measurement in all stands may allow:

1. Mill setup after a roll change to a more precise initial setting than with existing methods.
2. Rapid display of the general condition of each of the stands during rolling, especially to indicate eccentricity in work rolls and backup rolls, or excessive roll roughness.
3. Determination if the mills are properly balanced in reducing thickness and if there are excessive mechanical load stresses on a mill stand.

Figure 5 shows the completed installation except for the top brass liners. The pressure blocks are in place over the load cells and are retained to the mill housing by four stainless steel pins. Electrical connections of the cells are made in the boxes mounted on the right-hand side of the mill spreader beam. Approximately 12 tons of material was machined from the mill housings using high speed cutting tools and a special milling machine designed by our machine shops. Figure 6 is the calibration curve for one of the units and was furnished by the manufacturer.

Figure 7 shows the addition to the speed control desks for the semi-automatic pushbutton control of the stand screws for stands 1, 2 and 3. A similar addition has been made at the other end of the speed control desks for stands 4, 5 and 6. The decade buttons on each of the desks select the desired screw position from zero to 4.999 in. A selector switch allows the screws to automatically position or alternately provides screw positioning when the operator presses a "screws-run"

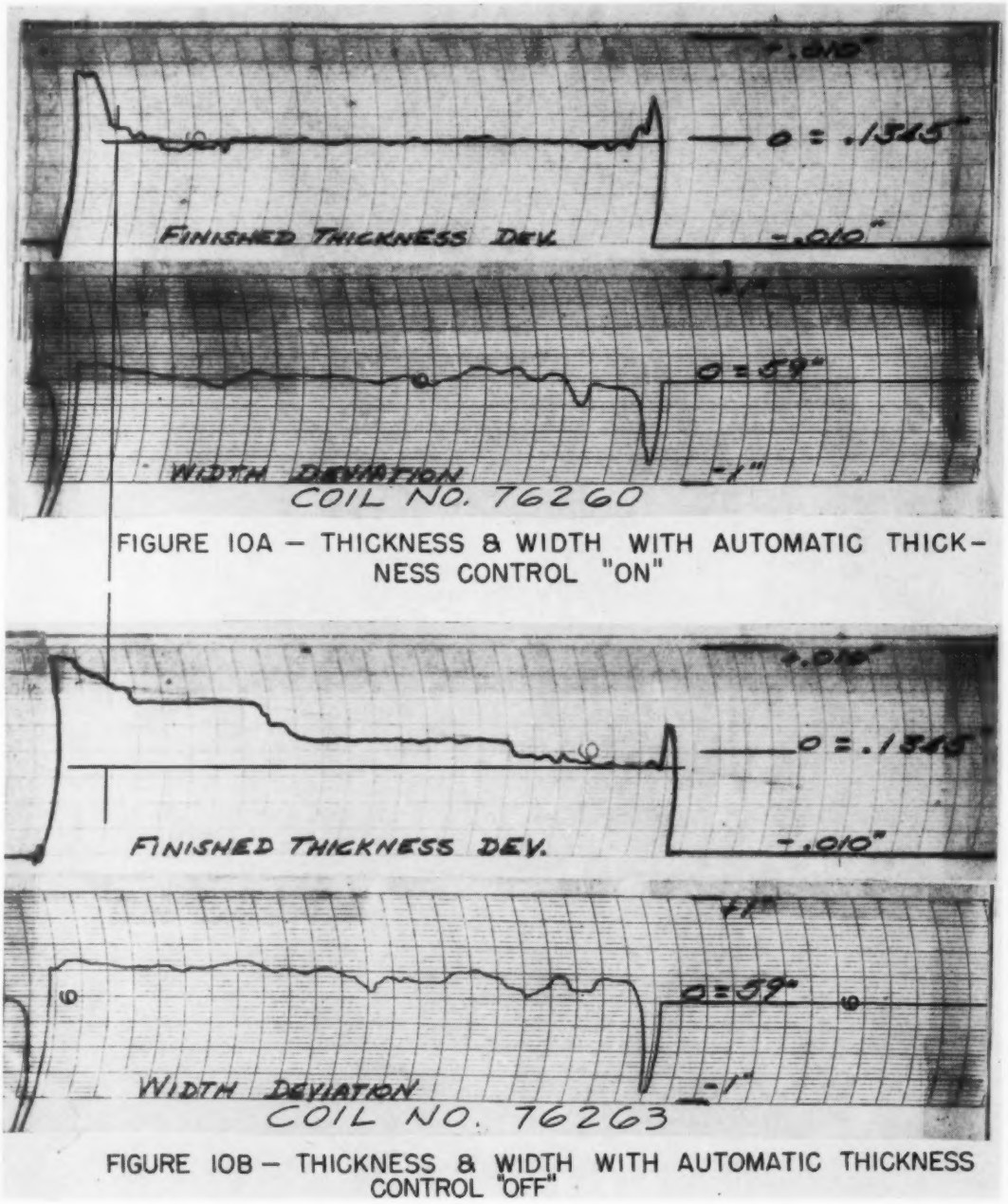


FIGURE 10A — THICKNESS & WIDTH WITH AUTOMATIC THICKNESS CONTROL "ON"

FIGURE 10B — THICKNESS & WIDTH WITH AUTOMATIC THICKNESS CONTROL "OFF"

Figure 10 — Thickness and width patterns for 0.135 x 59-in. strip shows product improvement with regulator.

button. The semi-automatic screwdown controls resulted in good co-ordinated control of mill setup. Manual control of screws and of sideguards are available. Large scale rolling force meters and a small rolling force differential meter are also provided. The differential meter indicates the difference in rolling force between drive and operating sides of each of the stands and may be used as an indication of mill roll level. A meter showing screw position error indicates screw action and checks the decade buttons against actual screw position. Above the desks are the counters which numerically indicate screwdown and sideguard positions. Directly behind the operator are setup panels for automatic thickness and screwdown control. Figure 8 shows the operator setup cabinet for three of the stands which contains regulator control switches, differential zeroing selsyns and related equipment, and adjustments for mill-drift and bar level temperature controls. In the background are the cabinets which house the static switching units, transistor amplifiers and related components.

The results which were obtained from this installation are perhaps the most important part of this report and the most interesting to mill operators. Figure 9 shows the difference in finished thickness with and without the regulator in operation. Figure 9A shows the results with the regulator "on" and Figure 9B shows the thickness and width pattern with the regulator "off". It may be noted that Figure 9B is acceptable thickness performance even without the regulator.

This exhibit represents two succeeding strip-slabs heated in the same furnace and shows that the regulator can make acceptable thickness even better. Figure 10 shows the patterns of regulator "on" and regulator "off" for a different product. Figure 11 shows a part of the data which was collected during the rolling of the

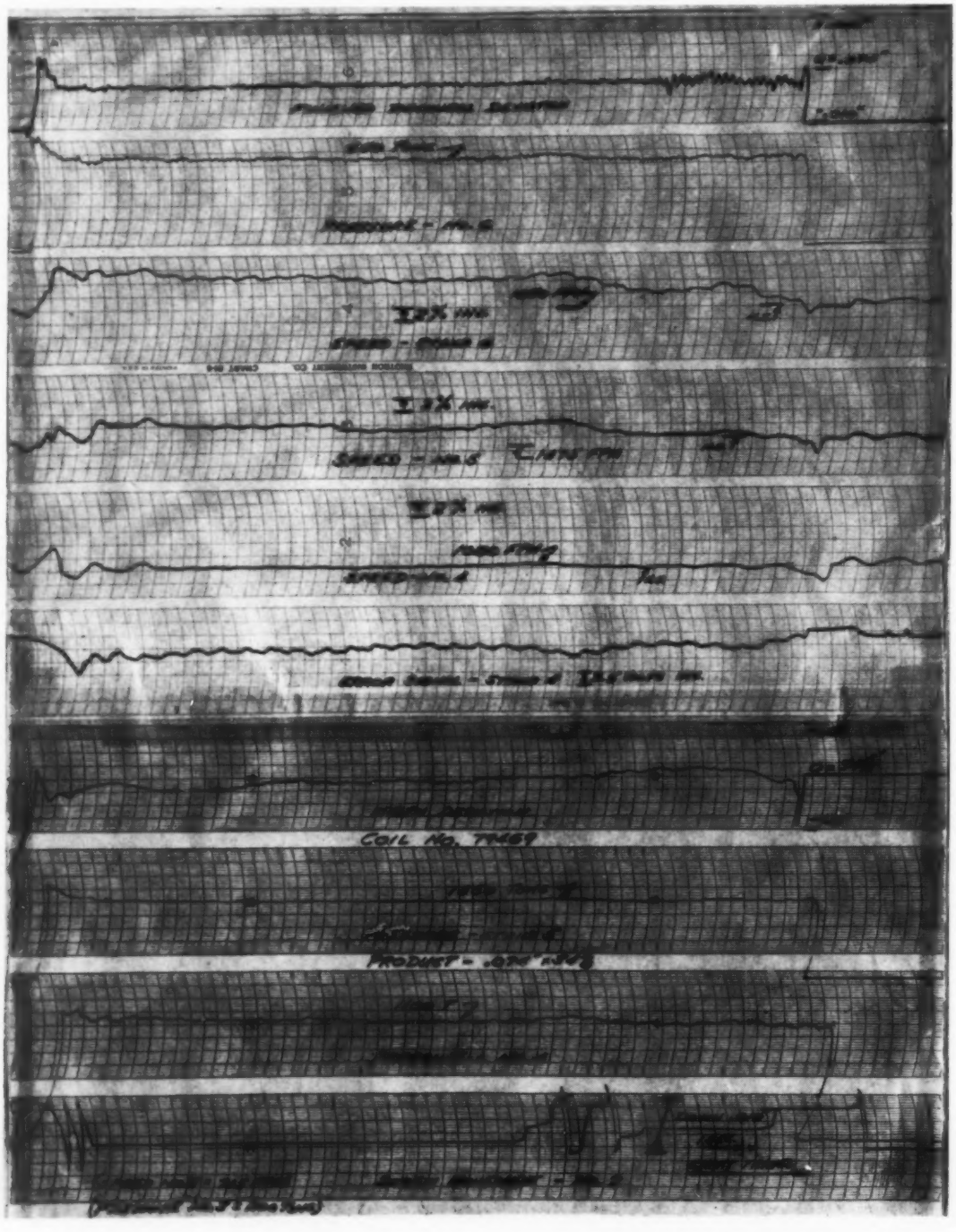


Figure 11 — Test data for the coil for which width and thickness is given in Figure 9A.

coil shown in Figure 9A. The rolling forces shown on Figure 11 are for one side of the mill only, the total rolling force being double that shown for the stands.

In Figure 11, stand 2 screw movements are shown and were operated in accordance with slowly increasing rolling force variation from stands 1 and 2. Stand 4 rolling force variations furnished the controlling signal for stands 4, 5 and 6 speed adjustments. The controls were set so that stand 4 speed adjustments were small in comparison with stands 5 and 6 speed adjustments. The stand 4 error signal is arranged to decay slowly after the trailing-end of the strip leaves stand 4.

The evaluation tests of this equipment by U.S.S. research involved approximately 1000 coils and over 300 of these have been analyzed and tabulated. The results of the tabulation show more than 70 per cent improvement in finished thickness deviation over the length of the coil, neglecting the extreme trailing-end.

These tests and the results shown in Figures 9, 10 and 11 indicate, also, some of the limitations of the present system. The speed-tension regulator cannot remain effective as the trailing-end of the strip leaves the latter stands. However, experience with the existing equipment and the data that has been accumulated will determine further improvements.

There are many possible approaches to automatic thickness control for continuous hot-strip mills. Each may substantially contribute to rolling mill practice. The combination speed-tension and screwdown system used at Geneva has accomplished the objective of producing hot strip with controlled dimensional quality. This has been achieved within the boundaries of sound economic considerations.

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Discussion

PRESENTED BY

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DR. R. B. SIMS, Chief Engineer, Research and Development, Davy and United Engineering Co., Ltd., Darnall Works, Sheffield, England

I. G. Orellana: You mention that a prerequisite for automatic thickness control is the installation of speed regulation. Since visiting your plant we have seen a hot strip mill which had recently been equipped with stand speed regulation and bus-voltage control on a common-bus voltage supply system.

I would like to limit my comments on your paper to this feature of your strip thickness control system. To obtain proper operation from your speed regulators did your find it necessary to provide bus-voltage regulation?

Would better speed and voltage regulation available by the use of individual rectifiers or motor generators for each stand drive motor have any appreciable effect on the rate of response of the automatic strip thickness control system on stand no. 4, 5 and 6?

In the past, you have stated that the 5000-hp finishing stand drive motors were inadequate for strip over 60 in. wide. When rolling strip approaching 60 in. in width, your drive motors are then operating near their rated capacity. Motor speed regulation at this load would be the poorest. With a speed regulation system in operation, presumably a "buck-boost" generator arrangement in the motor fields, the regulator action would tend to correct motor speed drop by field weakening with a consequent increase in armature current. Assume that at the same time the strip thickness control system requires a change in strip tension which adds further load on the drive motors. Under these circumstances the combined action of the two controls would place an excessive overload on the armature currents.

Would you care to comment on this action and its effect on the automatic strip thickness control system?

The data from our visit to Geneva in January has been very useful in specifying the type of automatic strip thickness control for our new 56 in. hot strip mill for Warren. The questions which I have made here as comments on your paper are some problems to which we have been seeking answers. Perhaps you have had experience with your control system that can be helpful.

L. E. Ringger and G. S. Koss: New bus-voltage regulators were installed in 1955 with the speed-regulating equipment for the finishing stands. Considering the bus-voltage regulators by themselves, they were able to closely and accurately control bus-voltage which was checked by a step-change in the reference circuit. However, the combination of bus-voltage regulators and speed regulators were very unstable with a high-gain voltage regulating system. This condition arises because both regulators were essentially controlling the same transient variable and had essentially the same response characteristics. Under these conditions oscillations can easily occur. The system was stabilized by "detuning" the bus-voltage regulators to obtain relatively slow response time. Computer and analytical studies have been made to determine methods for improved bus-voltage regulator response without interaction with the speed regulators. The suggested methods have not been installed since we have not been able to associate our existing bus-voltage regulation characteristics to adverse effects on the mill.

The capabilities of the speed regulators installed on the Geneva mill are much greater than has been allowed. It is possible to increase the speed regulator gain to a point where the motors at top speed and no-load will draw 250 per cent rated current while following a 10 per cent reference change. Operation of the finishing stands requires frequent large speed changes under rolling load conditions. At the same time the motor breakers are set to trip at 250 per cent load for motor protection. The rolling load current and the

impact speed-drop recovery current must not exceed the maximum permissible motor current. Normal rolling loads on wide light-gage strip are about 150 per cent rated motor current for the entry stands of the finishing mill and in addition there will be an impact speed-drop recovery current and also a possible reference change current.

These wide variations in possible peak motor currents under normal rolling conditions are limited by two means:

1. The speed regulator response is adjusted to obtain tolerable currents with a 10 per cent reference change. This results in a regulator action which causes approximately 150 per cent of rolling load current during impact speed-drop recovery conditions at a zero-droop setting.

2. Motor speed droop is controlled by the speed operator and is set at zero for all strip under 50 in. in width. Above 50-in. wide strip the speed operator sets the droop control at about three per cent or six per cent depending on the thickness being rolled. The use of droop control is to reduce impact speed-drop recovery currents.

With regard to speed-tension part of automatic thickness control, the control is inoperative until strip is in all stands at which time steady-state rolling conditions are practically in effect. It has been our observation that the response of the speed regulators to thickness control changes is sufficiently fast to obtain excellent thickness control results. The effect of thickness control on motor currents has been within tolerable limits since thickness changes do not vary as rapidly as vernier-speed-stick changes made by the speed operator.

Dr. R. B. Sims: Mr. Ringger and Mr. Koss have described a notable piece of research into mill control, for which they, their colleagues and the U.S.S. Corp. deserve great praise. Gage control at the finishing end of a hot strip mill has always been recognized as a difficult undertaking. The problem differs considerably from the corresponding cold rolling problem in that a cold mill operates as a true batch process. Each coil is accelerated from rest and may be regarded, from the point of view of control, as a separate entity. The hot mill, on the other hand, approaches more closely a "continuous" process. The mill is not stopped between bars, and frequently only three or four seconds elapse between them. This means that control of gage using the mill screws is made difficult since there is a risk that the rolls will not be reset after rolling a bar in time to receive the next one. The contribution which the authors have made to mill technology is to show that controlled tension stresses may be applied to hot material of sufficient magnitude to influence the strip gage appreciably and without uneconomic changes to the width of the material. The method of applying tension through changes in mill speed has led to the concept of the "stiff" hot mill—another first at Geneva. The effectiveness of these new techniques is demonstrated clearly in Figure 9 of the paper.

The authors have discussed the causes of off-gage in hot mills from the viewpoint of the finishing stands only, but the basic reasons for off gage are more fundamental, and far simpler. In a mill such as the semi-continuous plant at Geneva, the roughing stand delivers a bar on to the delay table at a greater speed than it enters the finishing train. This miss-match of mill speeds gives rise to the greater part of the gage errors discussed by Messrs. Ringger and Koss.

For simplicity suppose the final pass in the rougher is at 800 fpm, and we will assume the bar to be 160 ft long on the delay table, and the effective length of the table as 200 ft. Suppose also that the speed of the bar as it enters the first finishing mill is 200 fpm. The leading end of the bar will therefore spend 15 seconds on the delay table (i.e., 200 ft at 800 fpm) whereas the trailing end will spend 53 seconds on the table (40 ft at 800 fpm plus 160 ft at 200 fpm) and the differential cooling which takes place in the bar, usually on one inch or less thick, gives rise to a temperature gradient along the length.

Modern practice is to operate a strip mill with the loopers lowered, i.e., with a small tension (it is hoped) on the strip. This gives rise to a decrease in strip thickness as the material enters each of the finishing stands, and tensions are applied as the authors' results show clearly. As the cooler strip enters the mill, the gage increases and with it the load on the mill motors and the forward slip in the material. While the Geneva mill avoids the speed changes due to droop, the strip speed changes due to gage and slip cannot be avoided, and as a result the interstand tensions increase as temperature decreases. At the end of the bar the sudden release of this build-up of tension causes the rapid gage changes which are a characteristic of the hot strip mill.

The most effective ways of reducing the incidence of off gage in hot mills would be to match the speed of the roughers with the finisher—a technique common, for example in skelp mills but unfortunately impossible in conventionally built continuous wide strip mills where, in order to save on capital investment, the roughing mills are equipped with constant speed drives. The technique is, of course, quite impossible in semi-continuous mills. It is possible, however, to redesign the loopers of any mill so that they may be made to vary in height with the strip tension. It is doubtful if the majority of loopers in use today could accomplish this. With automatic control of loopers, the mill could be operated at a low, and substantially constant strip tension. This would avoid completely the rapid gage changes at the ends of each bar and give any automatic gage control system a much better chance of doing its job. The effectiveness of these techniques can be seen on any skelp mill where frequently a 40-ft slab is rolled with less than 0.002 in. variation from end to end.

The authors have doubtlessly considered these points in designing this controller, it would be valuable to have their comments.

L. E. Ringger and G. S. Koss: Dr. Sims proposes a system which eliminates the tension variable and compensates for other variables through the use of the screwdowns. The system selected for Geneva Works is, of course, based on the economic consideration of equipment and modification costs, and is based on the objectives which were to be accomplished. The merits of the system outlined by Dr. Sims should be evaluated with respect to cost and the desired objectives. ▲

Practical Aspects of Atmosphere Control

By R. J. PERRINE, Director of Research, Electric Furnace Co., Salem, Ohio

A vacuum is the only atmosphere which is completely neutral to all surfaces . . . . present practice, however, uses exothermic, endothermic, and dissociated gases . . . . correct atmosphere and temperatures are vital factors in product quality.

THIS paper deals with practical aspects of atmosphere control and related research problems. When one thinks of atmosphere control three basic atmospheres immediately come to one's attention. These atmospheres include exothermic rich and lean ratio, endothermic and dissociated ammonia gas atmospheres. Aside from these basic atmospheres there are a large number of prepared atmospheres tailored to do a specific job such as the N_2 base atmospheres. These atmospheres are prepared by scrubbing CO_2 from exothermic atmosphere and enrichening with H_2, reforming lean exothermic and the burning of dissociated ammonia gas. Since space does not permit a discussion of these various prepared atmospheres no further mention will be made of these atmospheres unless needed to illustrate a point. This paper will first review the generation of the three basic atmospheres for a common understanding of the subject matter.

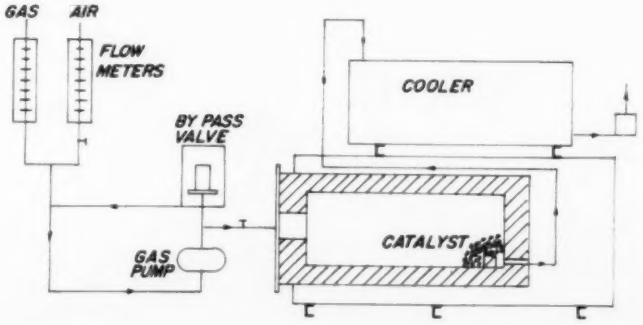
Figure 1, shows the component parts essential for the generation of exothermic atmosphere. The air-fuel ratio and volume flow are set by flowmeters to the desired operating conditions. A gas pump introduces the air-gas mixture into a refractory lined combustion chamber. The combusted products pass through a suitable catalyst and are introduced into a surface cooler. In the surface cooler the water content of the atmosphere gas is reduced from a high level, approximately 20 to 3½ per cent depending upon the temperature of the atmosphere as it leaves the surface cooler.

In the generation of exothermic atmospheres there is enough heat developed in the partial combustion of the mixture to develop a satisfactory reaction temperature. The temperature is dependent on the air-gas ratio and volume flow. Since these are specified for a given installation it is up to the designer to size the combustion chamber and insulate to provide a satisfactory reaction temperature. A satisfactory reaction temperature is from 2200 to 2600 F. In the case of nonferrous annealing, etc., where sulphur must be scrubbed from the protective atmospheres the higher temperatures are favored.

Reference to the special atmosphere chart Figure 2, shows the generated atmospheres for three of the most common fuels. These fuels include city gas, natural gas and propane. On the horizontal axis is plotted the per cent of perfect combustion and superimposed are the air-gas ratios for the three fuels in question. The vertical axis shows the per cent constituents in the generated atmospheres. Also, to be noted on the chart are the operating ranges for exothermic and endothermic type generators, explosive and nonexplosive ranges, and representative atmospheres which might be used in ferrous and nonferrous heat treating.

The equipment shown schematically in Figure 3 is used in the generation of endothermic atmospheres. It is essentially the same as that used for exothermic generation except the reaction chamber must be externally heated. In view of this requirement, the air-fuel mixture is introduced into an alloy retort containing a suitable catalyst. The endothermic generator temperature is somewhat independent of the air-gas ratio and volume flow because external heating is required to produce a satisfactory reaction temperature. A satisfactory reaction temperature and, equally important, equilibrium conditions are necessary to minimize the reacting po-

Figure 1 — Schematic flow diagram for exothermic generator.



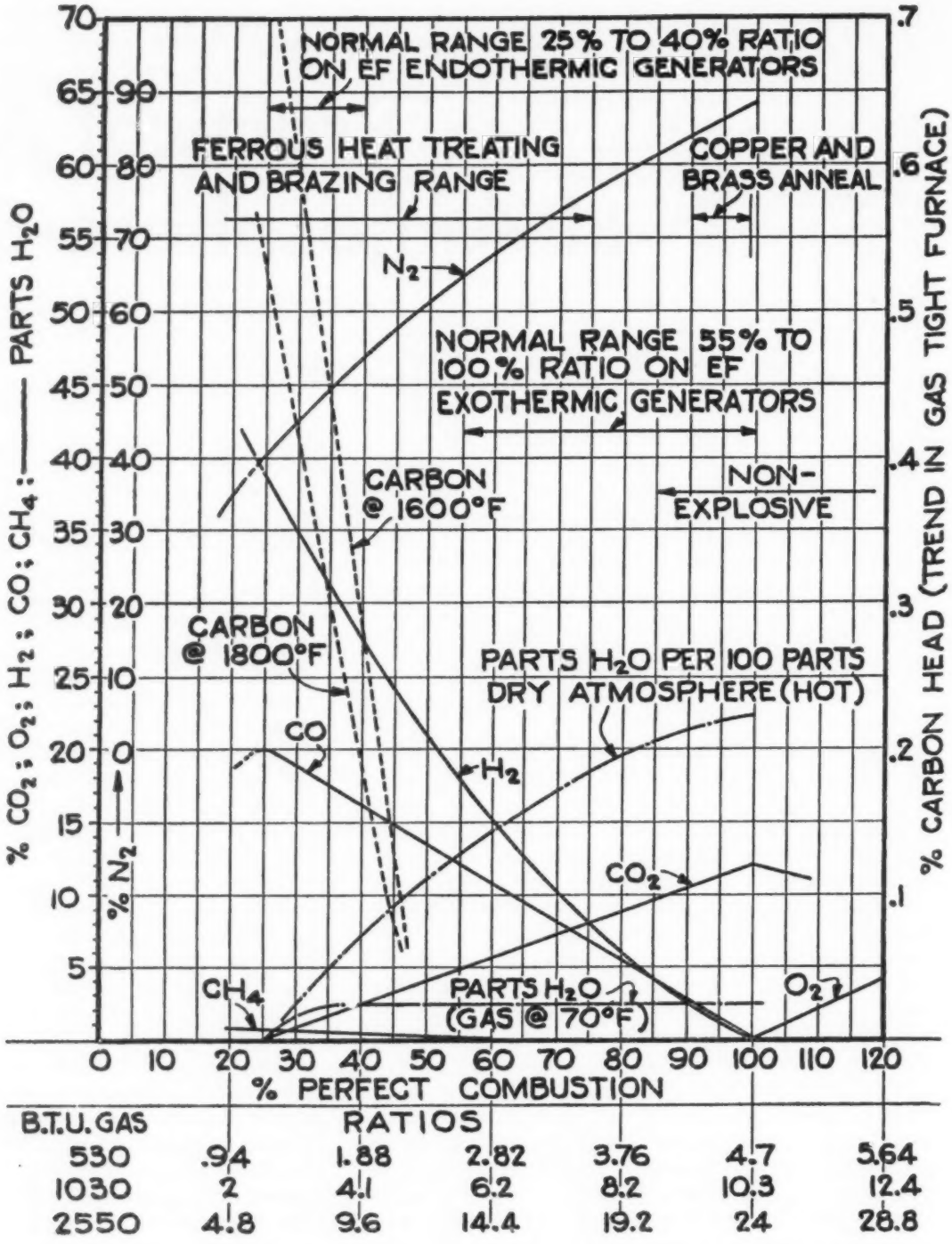

NORMAL RANGE 25% TO 40% RATIO ON EF ENDOTHERMIC GENERATORS
FERROUS HEAT TREATING AND BRAZING RANGE
COPPER AND BRASS ANNEAL
NORMAL RANGE 55% TO 100% RATIO ON EF EXOTHERMIC GENERATORS
CARBON @ 1600°F
NON-EXPLOSIVE
CARBON @ 1800°F
PARTS H2O PER 100 PARTS DRY ATMOSPHERE (HOT)
CO
H2
CO2
CH4
PARTS H2O (GAS @ 70°F)
O2
% CO2 ; O2 ; H2 ; CO ; CH4 ; —— PARTS H2O
% N2
% CARBON HEAD (TREND IN GAS TIGHT FURNACE)
% PERFECT COMBUSTION
B.T.U. GAS RATIOS
530 .94 1.88 2.82 3.76 4.7 5.64
1030 2 4.1 6.2 8.2 10.3 12.4
2550 4.8 9.6 14.4 19.2 24 28.8

Figure 2 — Special atmosphere chart is compiled from natural gas analyses. City gas and propane gas are similar.

tential of the atmosphere on reheating. Even though some heat is liberated in the partial combustion of the air-fuel mixture the heat requirements are predominately on the endothermic side, thus, the name endothermic generators. Even though the gas atmosphere chart, Figure 2, was extended to take in the generation of endothermic atmospheres, 25 to 40 per cent perfect combustion, (recirculation extends the range from 25 to 90 per cent perfect combustion) the results are best shown in Figure 4. This enlarged portion of the atmosphere chart gives one a magnified look at the performance to be expected in the generation of endothermic atmospheres. For example at an operating ratio of 2.6 air to 1 natural gas the CO_2 is 0.1 per cent, unreacted CH_4 0.4 per cent and the dew point of the atmosphere −14 C. A change in the operating ratio of only 0.025 from 2.6 to 1 to 2.625 to 1 results in a marked decrease in the quality of the atmosphere generated. The atmosphere resulting from leaning up the ratio 0.025 is 0.3 per cent CO_2, 0.4 per cent CH_4, and dew point −7.5 C. Since a slight change in the ratio represents such a marked change in the constituents, the ratio must be accurately set and maintained in this critical range.

One's first impression is that dew point allows more latitude for control purposes than the CO_2. The following Table I, shows the relationship of CO_2, vs dew point values for air-gas ratios of 2.6 to 1, 2.65 to 1, and 2.75 to 1. The CO_2 varies from a value of 0.2 to 0.6 per cent or 0.4 of 1 per cent while the corresponding dew points vary from −12.5 to 3 C or 15.5 C for 0.4 per cent change in CO_2. However, by using a precision CO_2 analyzer such as the infrared which is accurate to ±0.005 per cent it is apparent that there is no choice as to whether the control is dew point or CO_2. At the upper end of the dew

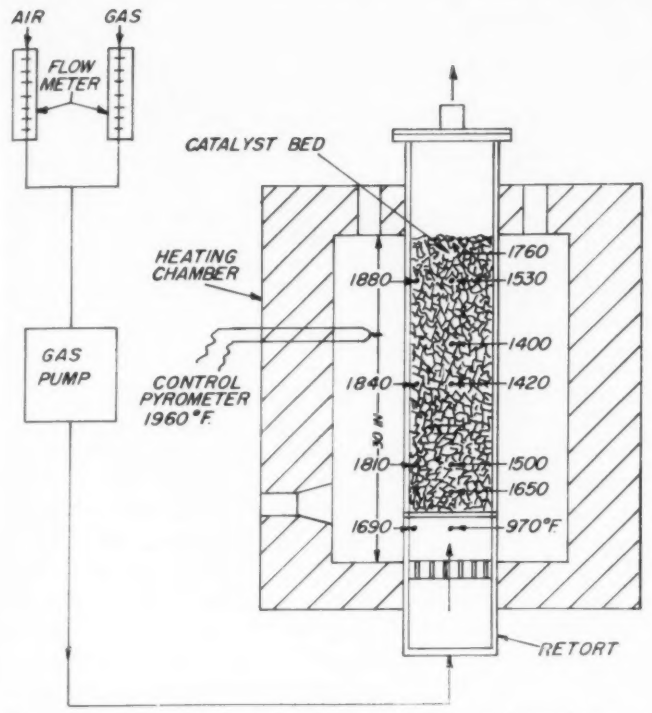


Figure 3 — Schematic flow diagram for endothermic generators.

point curve, above the knee, the CO_2 control may be more accurate than the dew point. To summarize a change in the air-gas ratio of 0.1 results in a dew point change of 14 to 17 C. Further generalization indicates that a change of one cu ft in the volume flow of natural gas on a 1000-cfhr capacity unit changes the dew point approximately 1 to 2 C in the operating range of −14 to −17 C dew point. In the above operating range a change of 0.1 in the CO_2 represents a dew point change of 3 to 4 C.

Figure 4 — Enlarged portion of atmosphere chart.

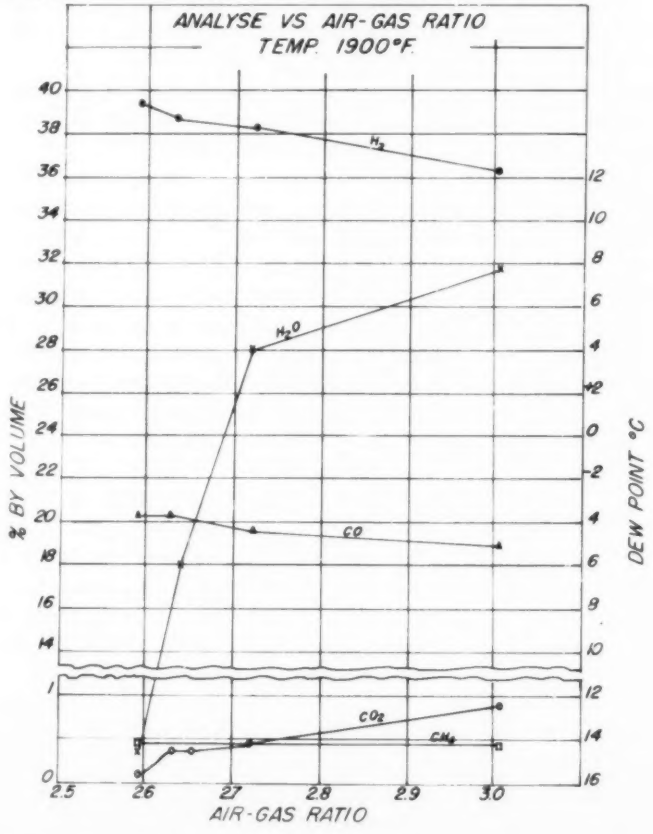


TABLE I

CO_2 Values and Corresponding Dew Points

Constituents	Ratio—air-to-gas		
	2.6–1	2.65–1	2.75–1
CO_2	0.2	0.4	0.6
O_2	0.0	0.0	0.0
H_2	39.0	38.6	38.4
CO	19.4	18.5	17.4
CH_4	0.4	0.4	0.3
N_2	Balance	...	...
Dew Point, C	−12.5	−4.0	3.0
Dew Point, F	9	24.8	37.4

Generation of the last basic atmosphere to be discussed, dissociated ammonia, is shown in Figure 5. The liquid ammonia passes through a vaporifier (heat exchanger) into an externally heated spiral coil or retort filled with catalyst.

In most cases these units are operated at a temperature of 1800 F. The liquid ammonia used in the generation of ammonia gas atmosphere should be an anhydrous refrigerant grade which should not contain over 0.05 per cent moisture by weight. Dissociated ammonia gas atmosphere from this quality of ammonia should show dew point values lower than a −50 F. A dissociated ammonia gas atmosphere having a dew point of a −50 F or lower and residual ammonia not over 80 to 100 ppm is suitable for annealing both the 300 and 400 series stainless steels.

The quality of any atmosphere generated depends largely on the following four factors:

1. Air-fuel ratio.
2. Reaction temperature.
3. Catalyst.
4. Detention time.

The first two factors, air-fuel ratio, and reaction temperature, have been discussed in reviewing the generation of the three basic atmospheres. The other two factors, catalyst and detention time, which affect the quality of the gas atmosphere will be discussed in the above mentioned order. The catalyst is powerless to change equilibrium conditions but does increase the reaction speeds. Reference to Tables II and III show the effect of catalyst on the generation of exothermic and endothermic atmospheres. A comparison in each case with and without catalyst demonstrates that the quality of the gas suffers where no catalyst is present. Sometimes even though a catalyst is present little if any benefit is obtained. In other words, if the catalyst is not very active, the quality of the atmosphere is impaired. The activity of a catalyst is affected appreciably by extremely small amounts of foreign substances. A foreign substance may react with the catalyst or blanket the surface to prevent contact thus reducing the efficiency of the catalyst. An example of each of these may be observed in endothermic generators where in the former instances the sulphur will combine with the metallic nickel of the catalyst forming nickel sulphide or in the latter case soot will be deposited on the catalyst blanketing its action.

The last factor to be discussed is detention time. The detention time is the time a particle or unit volume of

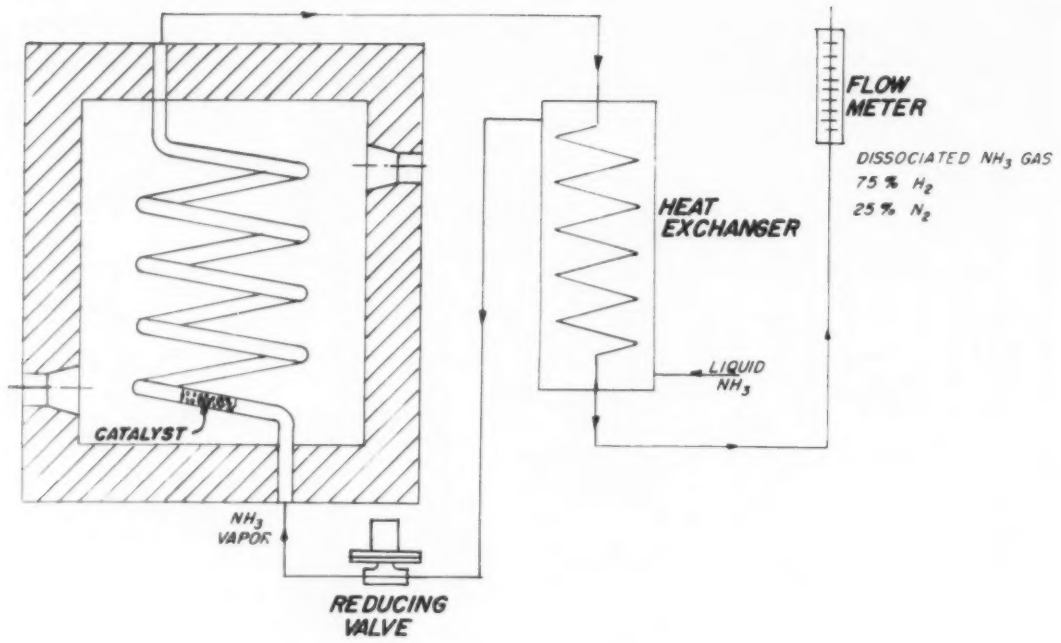


Figure 5 — Schematic flow diagram of ammonia dissociator.

the gas is in the reaction chamber. The required detention time will depend upon the type of atmosphere being generated. For example an exothermic lean ratio atmosphere will require less detention time than an exothermic rich ratio or endothermic type atmosphere. However, in any case, the time should be sufficient to reach equilibrium conditions. Times in excess of that required to reach equilibrium will have no affect on the quality of the generated gas, while too little detention time will impair the quality from the bright annealing or carbon potential standpoints. No definite time values can be assigned since there are several factors affecting detention time such as temperatures, catalyst and the response of the fuel to reacting.

One of the foremost problems in atmosphere control is quality control from a bright annealing or carbon potential standpoint. The quality of a bright annealing gas can be evaluated with the aid of a visual tester, dew point readings and complete gas analysis. Complete gas analysis with the most modern gas machine however will leave something to be desired. Even in the hands of a skilled technician the degree of accuracy is only ±0.05 per cent. With the exception of O_2 this error is of no real importance in determining the concentration of gases. However in bright annealing, amounts of O_2 as little as 0.02 per cent will in some cases poison the bright annealing atmosphere to the point where the metal surface of the product comes from the furnace discolored by oxidation.

A visual tester will qualitatively determine the bright annealing quality of an atmosphere. It is sensitive to O_2 contents of 0.02 per cent or less. The average shop personnel can operate the machine with good results and besides being able to detect traces of oxidizing gases, can evaluate the bright annealing qualities of an atmosphere.

The visual tester, Figure 6, consists essentially of a resistance heating circuit and a glass tube for confining the atmosphere around a metal test strip. The test strip is clamped between two electrodes which extend out of the glass tube through rubber stoppers. They are in turn clamped into the heating circuit. These electrodes are made from copper tubes which provide the atmosphere inlet and outlet. The temperature of the test strip can be varied from room temperature to 2000 F by varying the current flowing in the circuit with the carbon rheostat. An ammeter is provided for regulating and holding the strip temperature by varying or holding the current flow at predetermined values.

After gas pickling the test strip by heating to 1800 F in the atmosphere the current is reduced so that the strip temperature ranges from 1000 F at the center to 400 F at the terminals. This temperature range is most critical for oxidation or discoloration since in this range the oxidizing gases are more active than the reducing components. Visual tester results are generally reported as the holding factor or H.F. of the gas being tested (see Table II). The holding factor is a time measurement

TABLE II

Exothermic Generator Performance With and Without Catalyst

Ratio	Catalyst	Temp, F	Atmosphere, per cent						
			CO_2	O_2	H_2	CO	CH_4	H_2	H.F. (Holding factor)
7.1- 1	No	2285	7.1	0	8.3	7.1	0.2	77.3	¾
7.2- 1	Yes	2360	7.2	0	8.0	6.9	0.2	77.7	1¾
6.5- 1	No	2210	6.0	0	11.4	8.8	0.7	73.1	0
6.5- 1	Yes	2220	6.1	0	12.4	8.8	0.2	72.5	2¾
5.25-1	No	1980	5.0	0	13.3	9.6	2.1	70.0	0
5.19-1	Yes	1930	5.1	0	18.6	11.0	0.3	65.0	4

TABLE III
Endothermic Generator Performance With and Without Catalyst

	No catalyst	Catalyst
Ratio air-gas	2.57	2.57
Flow cfhr	550	550
Temp., F	1950	1950
CO_2	2.0	0.0
O_2	0.0	0.0
H_2	27.9	39.6
CO	15.7	20.3
CH_4	7.1	0.9
N_2	47.3	39.2

starting when the strip reaches 1000 F until discoloration puts in its appearance on the test specimen. This qualitative value is a measure of the bright annealing quality of the atmosphere and a value of three minutes is usually obtained on a steel strip for an atmosphere of 65 per cent perfect combustion. On a copper strip a holding factor of eight hours for an atmosphere of 95 per cent perfect combustion is considered satisfactory. An atmsophere of dissociated ammonia gas suitable for bright annealing stainless should show a holding factor of 15 minutes on a stainless strip.

The visual is also a useful tool for diagnosing bright annealing difficulties. A holding factor on the generator gas, if up to the usual standards, will eliminate any generator difficulty from the picture. Failure to bright anneal is then confined to difficulties in the furnace. A holding factor on the atmosphere from the furnace and cooling hood section should throw some light on the probable source of the trouble. Free O_2 or excessive moisture in the cooling hood will result in oxidation of the steel strip and decreased holding factor values. Water vapor will have no effect on a copper strip while free O_2 will result in a zero holding factor.

Endothermic atmospheres are used mainly in the heat treating of various carbon steels where the carbon level of the product must be maintained, for carbon correction, and as a carrier gas for gas carburizing. The quality of the gas atmosphere from a carbon potential standpoint can be checked by actual tests or dew point carbon pressure correlations. Carbon pressure checks are obtained by exposing high and low carbon shim stock to the atmosphere at the desired heat treating temperature for a sufficient time to establish equilibrium after which the final carbon content of the shim is determined. This gives a true equilibrium condition since the carbon level was approached from both a high and low level. For a schematic illustration of this process refer to Figure 7. Figure 8 is a correlation of a carbon pressure test vs dew point readings at various temperatures. The family of curves shown in Figure 8 are quite broad due to the fact that they were prepared from many field checks as well as laboratory work and consequently represent a very wide range of conditions. If points are developed for a given furnace, endothermic atmosphere, and technique, the bands will be narrowed considerably. Another factor to be considered is the unreacted CH_4 content of the generated gas and CH_4 addition. Endothermic atmosphere gas low in unreacted CH_4 shows less spread on the carbon shim stock method of testing than those having a high CH_4 content. The addition of CH_4 to increase the carbon pressure still further complicates the problem resulting in a wide spread of points. If the dew point or CO_2 content could also be evaluated in combination with the CH_4, CO and H_2 a more represented correlation could be obtained. However a close enough correlation between carbon pressure and dew point or CO_2 values can be obtained to permit a satisfactory method of control. There are several dew point machines which give satisfactory results and any infrared analyzer which will accurately determine CO_2 values within ± 0.005 also can be used to successfully correlate carbon potentials.

Any mixture of gas containing CO_2, H_2O, H_2 and CH_4 will react to satisfy equilibrium conditions when reheated in a furnace if conditions are different than those under which the gas was generated. Factors contributing to further reacting are temperature changes, contaminates carried in with the product, air infiltration and unstable gases.

The following illustrations show how equilibrium conditions are influenced by the above factors. Small quantities of air infiltrating into the heating chamber may not cause serious difficulties since the O_2 will react with the atmosphere increasing the CO_2, and H_2 values. A limited increase in the oxidizing content of the atmosphere in the heating zone may not affect the bright annealing qualities of the atmosphere, since the reducing quality of the atmosphere may be sufficiently high to accommodate a small increase in oxidizing gases. During the cooling stages of heat treating cycles especially in the critical range from 1200 F down to where the oxidizing gases are more active than the reducing gases, the reverse is true. Any trace of free oxygen in the atmosphere will result in oxidation or discoloration of the metal surface. If the bright annealing quality of the furnace atmosphere is to be maintained, the volume of atmosphere introduced must be adequate to prevent the backward diffusion of air or reacted gas from the heating chamber into the cooling hood. However, the volume flow can be minimized if adequate sealing methods are provided and maintained.

Even though the atmosphere requirements are satisfied at the work level there is danger of infiltration below this line because of chimney affect. Any openings however small, such as pin holes in welds, will allow the passage of air. The best solution to this difficulty is a gas tight enclosure.

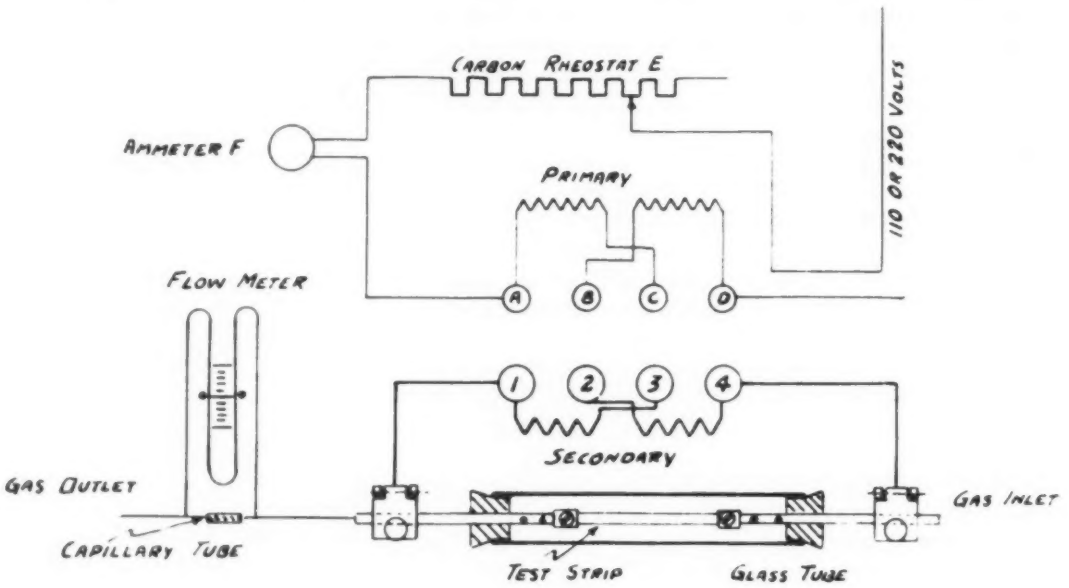
A source of difficulty is the diffusion of gases through a porous membrane such as might be used for gasket material on bolted joints. The rate of transfer depends upon the molecular weight, partial pressure of the gases and the permeability of the sealing material. Reference to Figure 9 demonstrates the passage of air through an $\frac{1}{8}$ in. asbestos millboard diaphragm. A holding factor as determined by the visual tester on the inlet gas showed a 3-minute value, while that on the outlet showed zero. An Orsat analysis on the inlet and outlet gases from the test chamber showed the same analysis values. This is understandable since the volume of air diffusing into the test chamber was too small to detect with a gas machine. However, there was sufficient volume to impair the bright annealing quality of the atmosphere. To prevent the transfer of O_2 in through the asbestos a pressure of $4\frac{1}{2}$ psi was required. Since pressures of this magnitude are unheard of in continuous production furnaces, gas tight welding of joints is preferred where feasible and where permeable gaskets must be tolerated, they are impregnated with a sealer to pre-

vent diffusion.

Contaminants carried in with the work such as roll or cutting oil change the composition of the resulting furnace atmosphere almost beyond recognition. Reference to Table IV, lists a typical endothermic gas introduced in a production furnace for the hardening of bolts. A comparison of the analysis of the atmosphere as produced in the generator with that taken from the empty furnace prior to starting production shows no significant change, which indicates the gas had been completely reacted in the gas atmosphere generator. Carbon potential checks showed a carbon level of 0.35 to 0.37 for the furnace idling conditions, no production being processed.

A check on the atmosphere under normal production conditions showed the CH_4 had doubled increasing from 0.9 to 1.8 per cent. This change in the atmosphere brought about by oil carried into the furnace with the product resulted in a slight increase in the carbon pressure level to a value of 0.4 per cent. The last column represents production with a heavy coating of oil which resulted in a marked change in the composition of the furnace atmosphere. The CO_2 decreased 0.2 per cent, the H_2 decreased 11.7 per cent and the CH_4 showed an increase of 2.7 per cent. As a result of these atmosphere changes the carbon pressure increased 20 to 40 points. These tests indicate that if it is desirous to maintain a given carbon level, removing oil from the product before charging into a furnace is a must.

Another example of atmosphere contamination is seen in the annealing of coils of cold roll strip in bells. Here large quantities of rolling oil are carried into the furnace. At the lower temperatures the oil volatilizes or distills off diluting the protective atmosphere. Atmosphere



SCHEMATIC ARRANGEMENT

Figure 6 — The visual tester is essentially a resistance heating circuit and a glass tube for confining the atmosphere around a metal test strip.

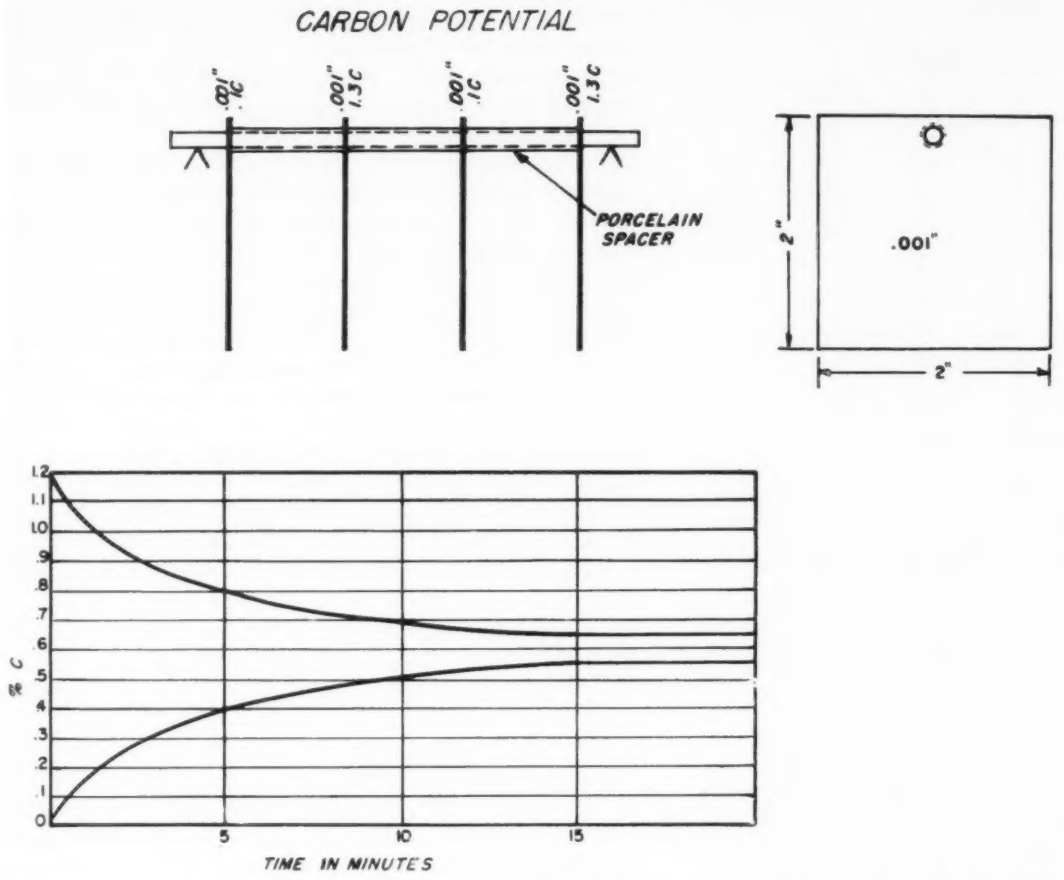


Figure 7 — Data for endothermic atmosphere at dew point of 50 F and furnace temperature of 1500 F.

samples taken at this stage contain tars and distillates beside the regular atmosphere constituents. As the furnace temperature increases the quantity of these products decrease and there is some reacting of the various components to satisfy equilibrium conditions. Figure 10, shows the change in composition that can be expected with respect to annealing time in bell type furnaces. As the temperature of the charge increases, the H_2 and CO values decrease by dilution from the formation of CH_4 and C_2H_6. After five hours the H_2 and CO values have reached a minimum of 8.5 and 11.5 and the CH_4 and C_2H_6 are at maximum values of 18 and 23 per cent respectively. After eight hours of heating there is some simulation between the gas surrounding the work and that introduced, the analysis of the two comparing favorably.

Another factor contributing to changes in the composition of protective atmospheres is the water gas reaction $CO_2 + H_2 \rightleftarrows CO + H_2O$. For example an exothermic 65 per cent of perfect combustion atmosphere

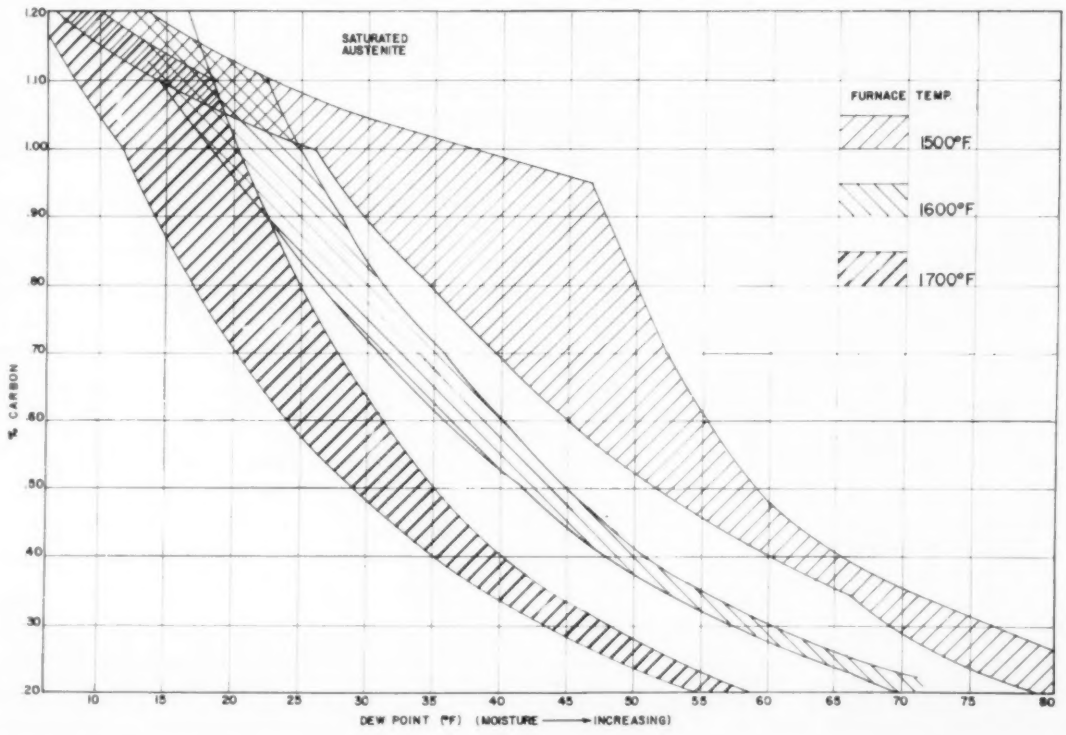


Figure 8 — Carbon potential vs dew point for straight carbon steels.

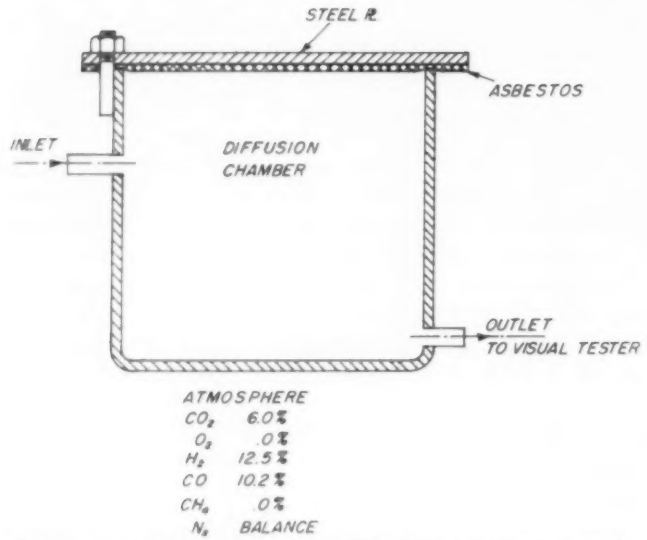


Figure 9 — Tests were made on diffusing air through ⅛ in. asbestos millboard diaphram.

gas reacted at 2300 F will have approximately 15 per cent of water vapor in equilibrium. Cooling the gas to room temperature and refrigerating reduces the moisture content to 0.8 per cent removing 14.2 per cent water vapor. Since, in usage, the atmosphere will undoubtedly be reheated to some lower temperature, new equilibrium conditions will be established. In reacting to establish new equilibrium conditions the driving force of the reaction will be to make more water. The water formed on reheating is given in Figure 11. For example if the above exothermic gas is reheated to 1600 F the moisture content will increase from 0.8 per cent as refrigerated to 6.5 per cent or a 100 F dew point. In view of this reaction the benefits of dehydrating are largely lost if the atmosphere is reheated. However in continuous furnaces atmosphere introduced in the cooling hood will react to a very small degree if any, thus taking advantage of a dry gas (better reducing quality), during the critical stages of cooling. The reaction can be avoided or greatly minimized by removing the CO_2. Further reference to Figure 11 shows curves for the increase in moisture or dew point of the same exothermic atmosphere on reheating when 75 and 90 per cent of the CO_2 have been removed. By removing 90 per cent of the CO_2 the moisture formed on reheating to 1600 F is one third less than that where no CO_2 was removed from the atmosphere. This is one of the advantages of CO_2 removal, because not only is an objectionable oxidizing gas removed but also the amount of moisture formed on reheating is greatly reduced.

In atmosphere control the problem of unstable constituents such as CO presents some difficulty. CO is unstable at low temperatures, especially in the range of 800 to 1200 F, cracking to deposit soot and free molecular O_2. The O_2 in turn combines with the CO and H_2 to increase the CO_2 and H_2O content of the atmosphere. The above reaction is illustrated in Figure 12 for an endothermic gas atmosphere plug natural gas additions. This gas is essentially the same as that used for gas carburizing. It was dried to a −45 C dew point and reheated to increasingly higher temperatures. From room temperature to 600 F there is little if any change in the composition of the atmosphere. Above 600 F the dew point and CO_2 content of the atmosphere increase rapidly leveling off or peaking between 900 and 1200 F. At this temperature the dew point reaches a value of a +8 C and the CO_2 increases from 0.6 to 1.7 per cent. As the temperature is increased further the dew point and CO_2 values decrease but never quite reach the original values.

An element balance at 1000 F shows that 2½ per cent C is lost as soot and there is also a loss of 1 per cent H_2 and 0.5 per cent O_2 which represents the exact ratio for the formation of water vapor. Actual measurement of the moisture content of the gas showed 0.82 per cent as compared with a calculated value of 1 per cent from the balance. The calculated amount of water agrees with that actually measured reasonably well considering the inaccuracies in Orsat determinations for the small amounts of the constituents that are involved.

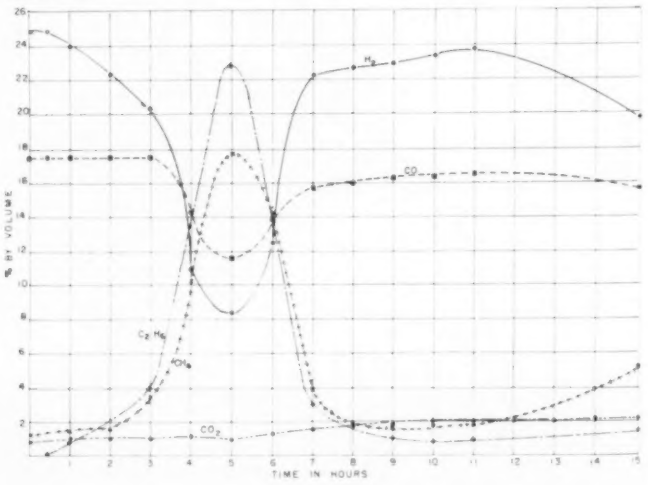
Since this critical temperature range exists in most production furnaces, this then is a contributing factor for an increase in CO_2 and dew point values over that of the atmosphere as introduced. It also emphasizes the importance of sampling for atmosphere analysis and dew point determinations from the hot zone of the furnace with a suitable sampling tube. Erroneous readings and difficulty in control will be experienced if true representative samples are not obtained.

Up to now we have been concerned with but a few of the problems related to atmosphere control such as the

TABLE IV
Endothermic Contamination From Cutting Oil on Bolts

Constituents	Atmosphere from generator	Atmosphere analysis from furnace		
		No production	Production oil usual amount	Production excessive oil
CO_2	0.5	0.8	0.8	0.6
O_2	0.0	0.0	0.0	0.0
H_2	37.7	38.8	37.2	25.5
CO	18.9	18.4	18.6	19.0
CH_4	0.9	0.9	1.8	4.5
N_2	42.0	41.9	41.6	40.4
Carbon Potential	0.10 per cent shim	0.35	0.40	0.62
	1.3 per cent shim stock (SAE 1038)	0.37	0.37 0.37	0.88

Figure 10 — Chart shows atmospheric contamination from roll oils.



effects of air infiltration, hydrocarbon contaminants, unstable constituents and reacting to establish new equilibrium conditions. Another aspect of atmosphere control is the reaction of the atmosphere to the metal surface in heat treating or annealing. This will be touched on now except for the carburizing or carbon correction which has been covered to some extent earlier in discussing the quality of endothermic atmospheres.

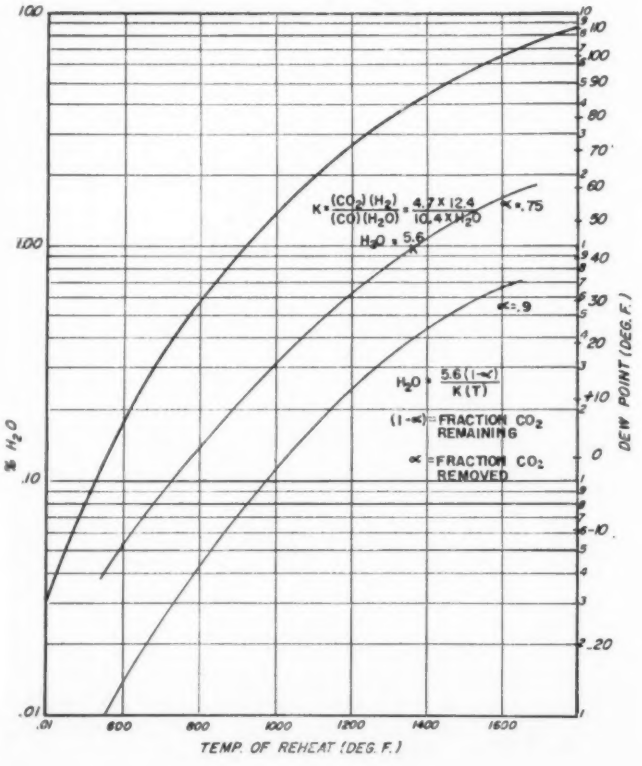
Certain grades of stainless steel annealed in dissociated ammonia gas atmosphere have an affinity for nitrogen pickup. The effect of nitrogen pickup on the heavier gages is not too critical but on the lighter gages, 0.005 in. and under, there is a pronounced deterioration in the physical properties. A number of tests were conducted to determine the source of nitrogen and a possible explanation of the mechanism.

Samples of both 301 and 347 stainless alloys 0.0025 x 2 x 2 in. were treated in a dissociated ammonia gas atmosphere with 48 to 50 ppm of residual ammonia. These samples were heated to a temperature of 1950 F and soaked for a time period of two minutes.

Nitrogen determinations on the 301 and 347 alloy before treatment showed 0.106 and 0.07 per cent respectively. After treatment the nitrogen in the 301 alloy had increased to 0.328 per cent and for the 347 alloy had reached a maximum value of 0.24 per cent.

To be sure that the residual ammonia in the dissociated ammonia gas remained at the same level in the furnace as that in the gas introduced, determinations were made on the atmosphere from the furnace. These determinations showed values of 46 to 48 ppm residual. Since the values of residual ammonia from the furnace were essentially the same as those in the dissociated ammonia gas atmosphere introduced, it can be concluded that there is no increase in residual ammonia on heating. Calculations show that the amount of nitrogen

Figure 11 — Curves give water content of partially burned gas after reheating.



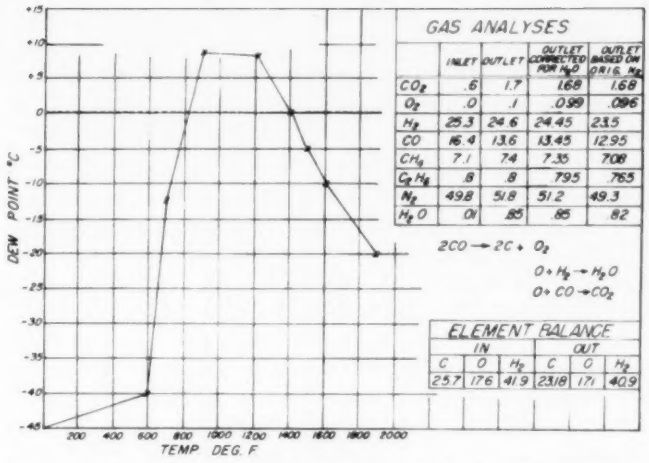

DEW POINT °C
TEMP. DEG. F
GAS ANALYSES
INLET
OUTLET
OUTLET CORRECTED FOR H_2O
OUTLET BASED ON ORIG. N_2
CO_2 .6 1.7 1.68 1.68
O_2 .0 .1 .099 .096
H_2 25.3 24.6 24.45 23.5
CO 16.4 13.6 13.45 12.95
CH_4 7.1 7.4 7.35 7.08
C_2H_6 .8 .8 7.95 7.65
N_2 49.8 51.8 51.2 49.3
H_2O .01 .85 .85 .82
$2CO \rightarrow 2C + O_2$
$O + H_2 \rightarrow H_2O$
$O + CO \rightarrow CO_2$
ELEMENT BALANCE
IN: C 25.7, O 17.6, H_2 41.9
OUT: C 23.8, O 17.1, H_2 40.9

Figure 12 — Curve gives equilibrium change on reheating double cracked atmosphere.

introduced in the residual ammonia during the heat treatment to be 0.00238 gram. A set of figures for the treated specimen show that the nitrogen in the 301 alloy had increased 210 per cent or 0.0138 gram and the 347 alloy 243 per cent or 0.0121 gram. The sum of the above figures give an increase in nitrogen for the heat treated specimen of 0.0259 gram. This is an increase in nitrogen of 9.1 times more than introduced by the residual ammonia in the atmosphere.

Additional tests were conducted to determine the maximum nitrogen pickup and also to determine if scrubbing to completely remove the residual ammonia from the atmosphere would change in any appreciable way the nitrogen pickup. Scrubbing to remove the residual ammonia was accomplished by bubbling the dissociated ammonia through a weak solution of H_2SO_4 and drying to a dew point of −50 C. Tests were conducted on the foregoing mentioned raw stock at temperatures of 1650, 1800 and 1950 F. The specimens were heated for time periods of 2, 20, 60, 120 and 240 minutes. Residual determinations on the dissociated ammonia gas atmosphere showed the usual 48 to 50 ppm while on the scrubbed atmosphere the residual was completely removed.

Figures 13 and 14 show a summary of the results obtained under the different conditions of treatment. Examination of the nitrogen curves for the 301 alloy, Figure 13, show some interesting results. First, the 301 alloy heat treated at 1950 F shows the same amount of nitrogen pickup for both the unscrubbed and scrubbed atmospheres. The nitrogen pickup curves for atmosphere containing 48 to 50 ppm residual ammonia for all practical purposes coincide with the curve for atmosphere containing no residual ammonia. These results substantiate the finding earlier in the investigation that the nitrogen pickup in the stainless alloy is not a function of the residual ammonia in the dissociated ammonia gas atmosphere. Second, it is noted that for short periods of exposure (two to three minutes) the rate of nitrogen pickup is less at the lower temperatures (1650 and 1800 F) than at the higher temperature (1950 F). However, at longer exposure times, from 100 minutes up, the rate of nitrogen pickup at the lower temperatures was several times that obtained at the higher temperature of 1950 F. Third, at the higher temperature of 1950 F the curve has leveled off indicating that a point of saturation has

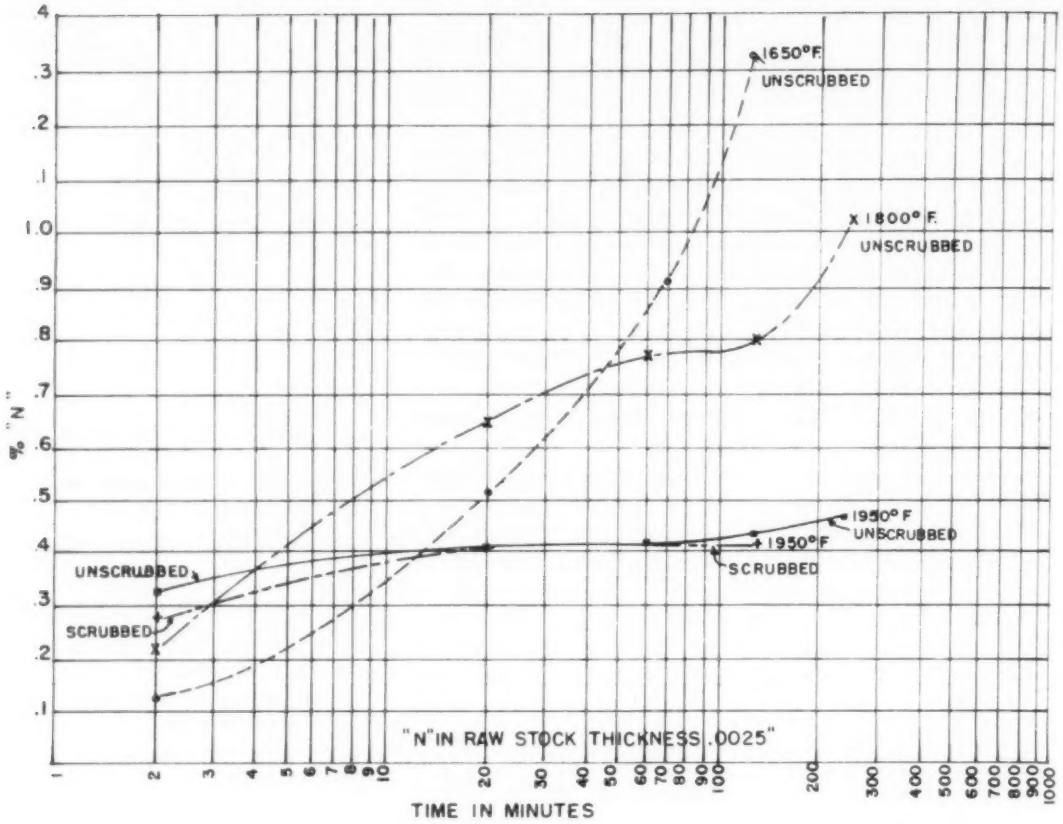


Figure 13 — Saturation of 301 alloy for various times and temperatures.

been reached corresponding to 0.4 per cent nitrogen. For the lower temperatures of 1650 and 1850 F the slope of the nitrogen curves are increasing with time and show no indication of leveling off. The nitrogen content has increased to one per cent for the 1800 F and 1.3 per cent for 1650 F temperature.

Figure 14 indicates the results of duplicate tests run on 347 stainless alloy. A comparison of the results as to the general slope of the curves, and the amount of nitrogen pickup very closely parallel the tests on the 301 alloy.

Since there seems to be no relationship of nitrogen pickup to the residual in the dissociated ammonia gas atmosphere, the question arises as to what is the mechanism of the phenomena whereby stainless alloy picks up nitrogen. A possible explanation may be that since the nitrogen and hydrogen are present in the correct proportions to form ammonia, a catalytic action pro-

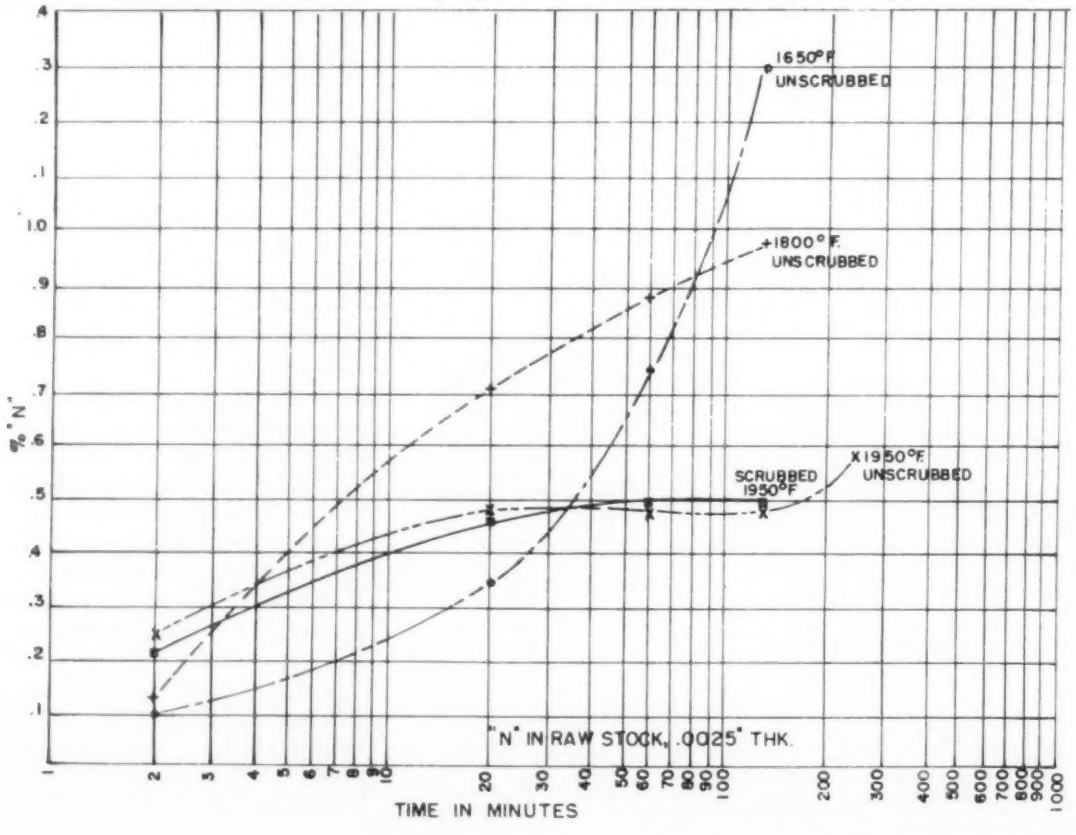
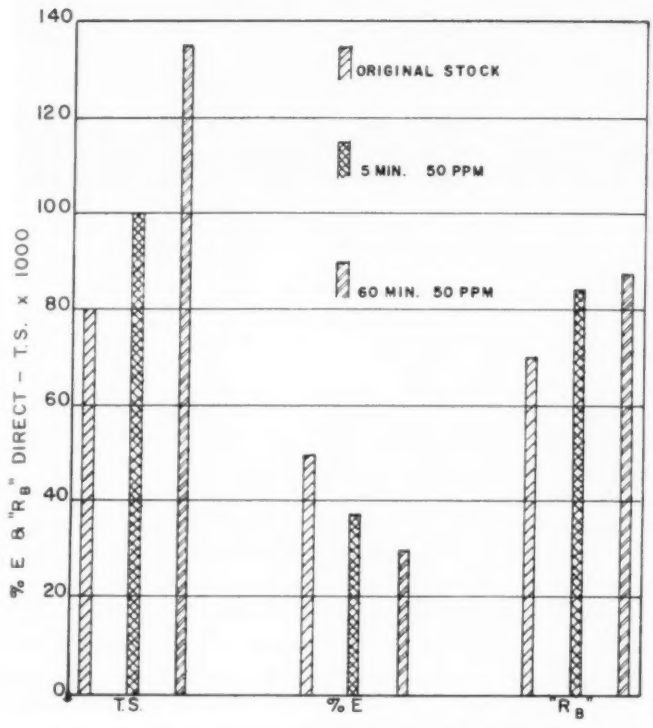


Figure 14 — Saturation of 347 alloy for various times and temperatures.



ALLOY	AS RECEIVED	1950°F, 50 PPM RESIDUAL	
		5 MIN.	60 MIN.
347	.044 – 46	.133	.345

Figure 15 — Nitrogen pickup has an important effect on physical properties.

vided by the metal surface may promote a small amount of ammonia reforming on the metal surface. This in turn dissociates forming nascent nitrogen which combines with the stainless metal.

A series of tests were conducted to show the affects of nitrogen pickup on the physical properties. Samples of 347 stainless 0.015 in. thick, having a nitrogen content of 0.046 per cent were heated to 1950 F for times of 5 and 60 minutes in a dissociated ammonia gas atmosphere. The atmosphere contained 48 to 50 ppm residual ammonia.

Reference to Figure 15 shows the affect nitrogen pickup had on the physicals under the conditions of the above test. The tensile strength increased from 80,000 psi for the as-received specimen to 100,000 and 130,000 psi for nitrogen levels of 0.133 and 0.345 respectively. Ductility values decreased from 50 per cent original to values of 38 and 30 per cent and the hardness values showed a corresponding increase, thus demonstrating that nitrogen pickup resulting in a decrease of the physical properties is detrimental from a forming standpoint.

Figures 16 and 17 also illustrate the effect of nitrogen pickup. Figure 16 is a photomicrograph of the 347 alloy as received and Figure 17 shows the effect of annealing in dissociated ammonia gas at 1950 F for two minutes. Intergranular penetration extends throughout the entire cross section of the specimen. This has a pronounced effect on the physical properties and corrosion resistance.

The question arises, what atmosphere can be utilized in the annealing of the stainless which will prevent nitrogen pickup. Two such atmospheres are hydrogen and a vacuum. The former, hydrogen, can be obtained in cylinders or bulk or from electrolysis but must be purified and dehydrated to bright anneal. Purification is usually accomplished by passing through a deoxo cell to remove oxygen which is converted into water. The water is then in turn removed by passing through absorbing units which results in a dew point of −50 F or lower suitable for bright annealing.

Vacuum annealing also eliminates the hazard of nitrogen pickup. While this method is relatively new it shows considerable promise in the continuous annealing of stainless alloys. We have bright annealed 200, 300 and 400 series alloys and the precipitation hardening grades such as 17–7 PH. The 300 series have been bright annealed in pressures up to 50 microns while the other alloys require a somewhat lower pressure. These have been annealed bright in pressures up to 10 microns.

The strip must be very clean prior to entering the equipment if low internal pressures are to be maintained. In this connection we have operated the equipment in our research department maintaining pressures down to below one micron. The pressure which can be maintained in the furnace chamber depends on:

1. Strip cleanliness.
2. Amount of out gassing from the strip.
3. The size and number of vacuum pumps which are supplied.

There is no doubt that vacuum annealing will be an important tool in the annealing of stainless alloys and may eventually be used in the annealing of steel strip. Heat treating in a vacuum is the only heat treatment 100 per cent neutral to all surface compositions. ▲

Figure 16 — Photomicrograph of the 347 alloy as received.

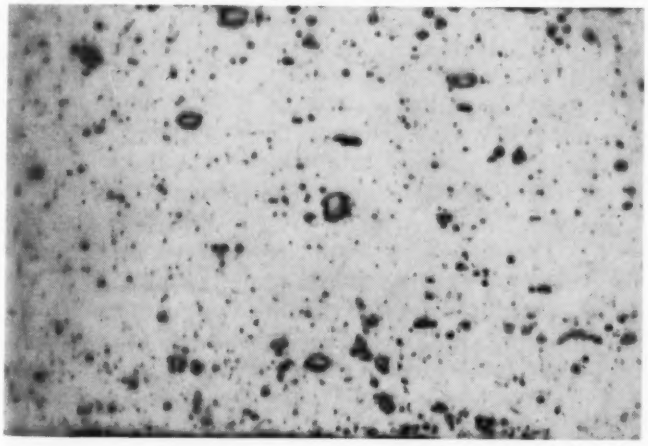
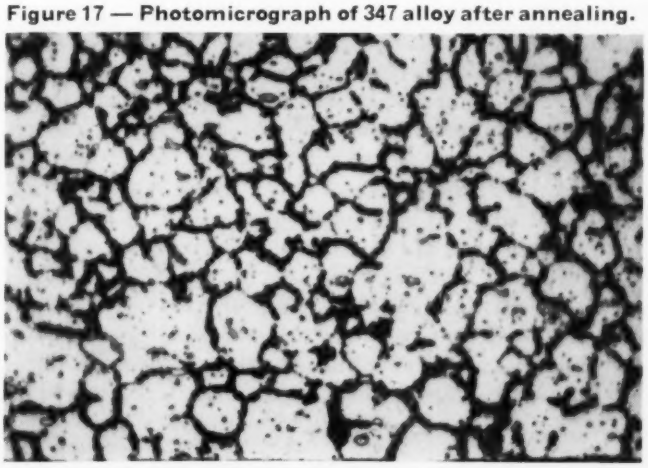


Figure 17 — Photomicrograph of 347 alloy after annealing.



By A. STRAUGHEN, Systems Development Engineer, Canadian Controllers Ltd., Scarsborough, Ontario, Canada

A-C Versus D-C for Crane

If d-c power is already available, the d-c hoist is undoubtedly cheaper than the equivalent a-c unit . . . . if d-c power is not available, a very careful study of the overall a-c and d-c schemes should be made before a final selection is established.

BECAUSE, with some justification, crane users, crane builders and crane control manufacturers have in the past looked on the d-c series motor as the optimum hoist drive, the general impression exists that it is still unrivaled. This view can no longer go unquestioned. Moreover when acceptance of the superiority of this kind of hoist drive is carried to such lengths that perfectly good and usable alternating current is rectified at the crane control panel and applied to a d-c hoist control, and when further the claim is advanced that this is even better than d-c control from a normal d-c source, then it is surely time to draw renewed attention to the potentialities for hoist drives of that simple, robust, dependable and, above all, cheap servant of industry, the a-c induction motor. This article is an attempt at an unprejudiced comparison of an up-to-date a-c hoist with its well tried d-c equivalent.

STANDARD FEATURES FOR A CRANE HOIST CONTROL

In a recent admirable article K. S. Kuka (1)* proposed a number of standard features for a d-c crane hoist control and illustrated them by means of the torque-speed characteristics for the drive to the hoist gear-box which are reproduced in Figure 1. In Figure 2 are shown torque-speed curves for a two-motor a-c hoist, the operation of which is explained in some detail in the following. First, however, Mr. Kuka's proposed features will be taken in order and discussed in relation to the characteristics in these two figures.

"1. Each hoist controller should give five distinct and stable speed-torque curves both for hoisting and lowering cycles. The speed-torque curves should have as equal a spacing as possible and shall not intersect each other at any point from the light hook to about 125 per cent rated load of the crane."

In addition to the required five points for handling substantial loads the curves in Figure 2 show a sixth point which may be brought into operation automatically on the fifth point setting or by master switch movement beyond the fifth point setting. This provides high-speed hoisting and lowering of light loads and empty hook. The characteristics are more closely spaced at low speed than at high speed, since it is considered that the crane operator requires fine speed control at low speed and transition points to full speed. Nobody wants to operate at, say, 75 per cent full speed. In the lowering direction the points 4 and 5 characteristics intersect at approximately the drive torque required to brake 120 per cent load on the hook.

"2. The first-point hoisting shall give a stalling torque of 125 per cent load so that the load is prevented from drifting downwards."

The first point hoisting characteristics in Figure 2 will just fail to raise full load. It will hold about 125 per cent load.

"3. The first-point maximum hoisting speed shall be maintained within about 40 per cent of the full load hoisting speed so that the slackness of the rope can be taken up smoothly without jerks or inching the control."

This requirement is fully met by the first and second point hoisting characteristics in Figure 2. Features 4 and 7 are best considered together.

"4. The hoist curves shall be so spaced that it would be easy to lift rated load rapidly without creating heavy accelerating current kicks in the motor armature."

"7. The control circuit shall be designed such that the transient current peaks are maintained within 225 per cent of the motor's one half hour rated full load current, and the transient torque peaks at the motor shaft are maintained within 250 per cent of the motor's one half hour rated torque."

The current peaks specified above are not applicable to induction motors, which have no commutation troubles. Normal induction motor hoist practice may be followed yielding torque peaks of approximately the magnitude specified in feature 7.

"5. The first-point lower shall give a break-away torque to an empty hook and shall also provide a dynamic braking torque such that a 125 per cent rated load can be lowered at a speed not exceeding 40 per cent of the normal full load hoisting speed."

A break-away torque on first point lowering was not considered necessary when the hoist illustrated in

* Numbers in parenthesis refer to Bibliography at end of article.

Hoist Drives

Figure 2 was designed. It could easily be provided, however. A lowering speed of 40 per cent on point one lowering seems too high for accurate spotting. The speed is restricted by dynamic braking to approximately 10 per cent on first point lowering.

"6. The last point lower shall give maximum stability to the motor and shall provide a braking torque such that 125 per cent rated load can be lowered at a speed not exceeding 200 per cent of the normal full load hoisting speed."

In discussing this feature it must be borne in mind that a d-c hoist is deliberately designed to give higher speeds on full load lowering than on full load hoisting. A necessary consequence of this is finer speed control in the hoist direction than in the lower direction. In the induction motor hoist, full load is lowered at a speed only a few per cent in excess of full load hoisting speed and is held at that speed by the regenerative braking torque of the induction motor. The maximum regenerative braking torque available is well in excess of 300 per cent full load torque for the motor. This maximum, while high, is exceeded by the compensated dynamic braking torque available on points one to four lowering (2). Stability on all points is thus assured.

The d-c hoist achieves an efficient work cycle by means of high-speed lowering of full load and high-speed hoisting of light hook. The a-c hoist achieves an efficient work cycle by means of equal speeds of hoisting and lowering full load and high speed hoisting and lowering of light hook. Full load lowering speed on the d-c hoist will be substantially greater than full load lowering speed on the a-c hoist, which thus requires less exacting service from the brake. Work cycles are discussed in more detail in the following.

"8. Means shall be provided in the control circuit that will self-protect the crane against excessive over-speeding due to failure of any contactor, relays or the over-hoist limit switch."

Protection against over-speeding is inherent in the scheme illustrated in Figure 2. If the coils on all accelerating contactors were to fail simultaneously the maximum speed achieved in the absence of any corrective action on the part of the operator would be of the order of 180 per cent. As will be seen, the motor is rated to withstand higher speeds than this.

"9. The main circuit shall be so designed that preferably a maximum of nine contactors and seven resistance steps are used."

No meaningful comparison of the two schemes on the basis of numbers of control devices employed can be made. The best approach is probably that of cost of the

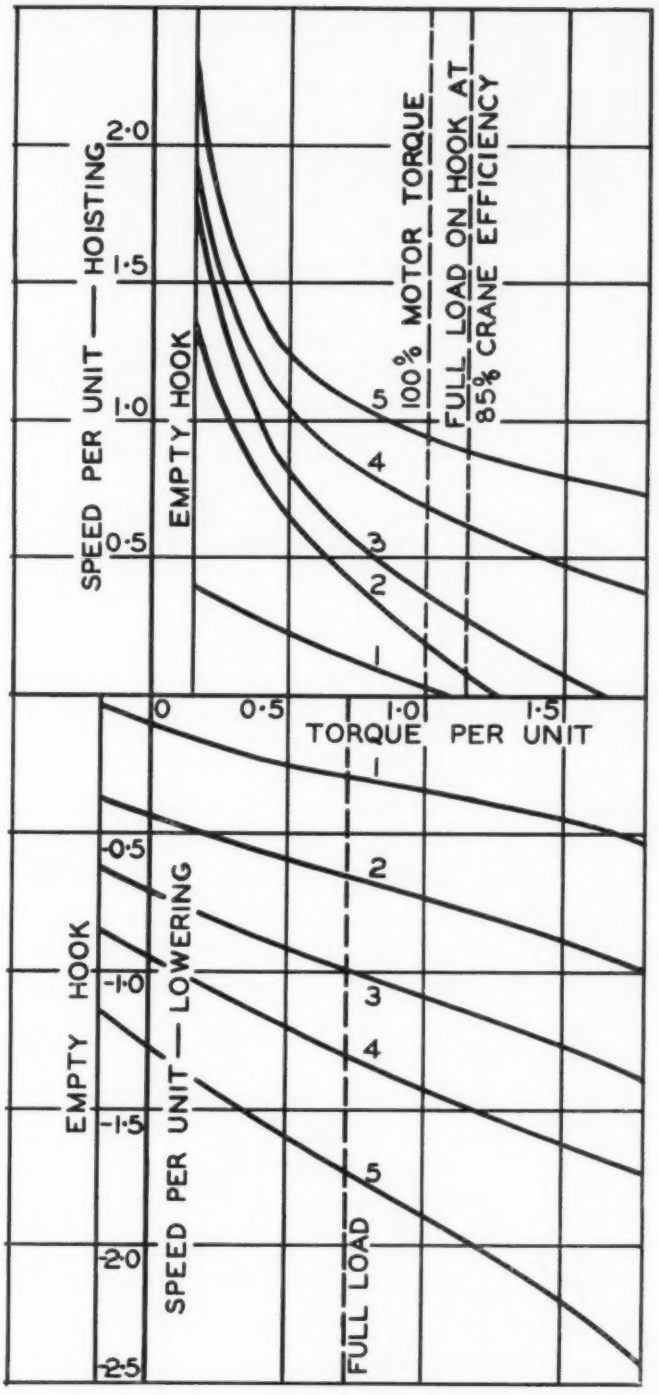


Figure 1 — These speed torque curves illustrate some proposed standard features for d-c crane hoist control.

installation, and this will be touched upon in the following.

In the light of the foregoing discussion it is scarcely possible to claim that handling of either hoist is superior to that of the other.

COMPARISON OF WORK CYCLES

Let the height through which the load must normally be raised be defined as unit distance.

Let the time taken for the hook to move unit distance at unit speed be defined as unit time.

Assume a work cycle in which acceleration periods may be neglected and in which unit time is employed in movement between the point of hoisting and the point

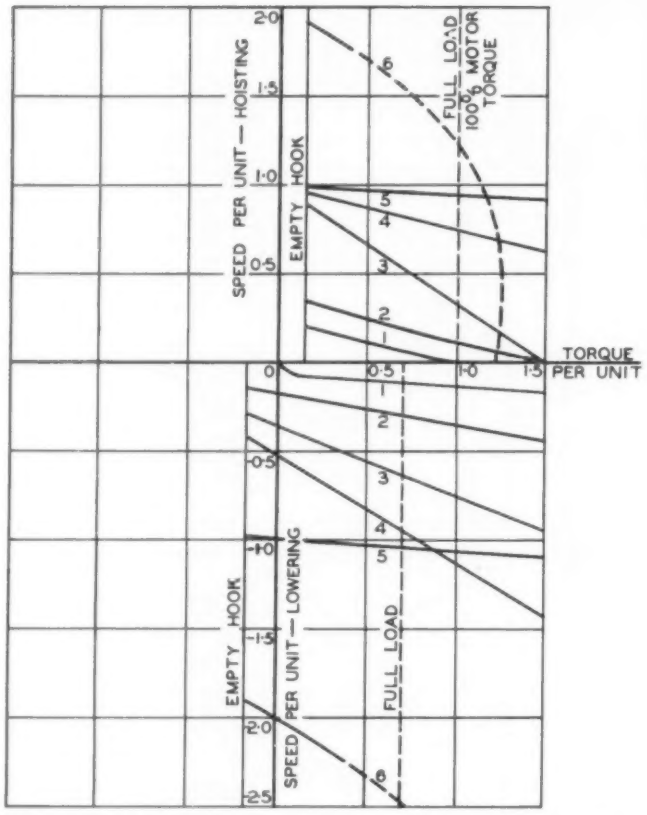


Figure 2 — Speed torque curves for a 2-motor a-c hoist.

of lowering the load or empty hook.

Consider first 100 per cent load. For the d-c series hoist, from Figure 1:

Time taken to raise full load	$= \frac{1}{0.89}$	= 1.12 Per unit
Time taken to transport full load	=	1.00 Per unit
Time taken to lower full load	$= \frac{1}{1.73}$	= 0.58 Per unit
Time taken to raise light hook	$= \frac{1}{2.32}$	= 0.43 Per unit
Time taken to transport light hook	=	1.00 Per unit
Time taken to lower light hook	$= \frac{1}{1.14}$	= 0.88 Per unit
Total time		5.01 Per unit

For the a-c hoist, from Figure 2:

Time taken to raise full load	$= \frac{1}{0.95}$	= 1.05 Per unit
Time taken to transport full load	=	1.00 Per unit
Time taken to lower full load	$= \frac{1}{1.05}$	= 0.95 Per unit
Time taken to raise light hook	$= \frac{1}{1.92}$	= 0.52 Per unit
Time taken to transport light hook	=	1.00 Per unit
Time taken to lower light hook	$= \frac{1}{1.90}$	= 0.53 Per unit
Total time		5.05 Per unit

Consider 50 per cent load. For the d-c hoist:

Time taken to raise 50 per cent load	$= \frac{1}{1.11}$	= 0.90 Per unit
Time taken to lower 50 per cent load	$= \frac{1}{1.45}$	= 0.69 Per unit
Time taken in transport and light hook movement	=	3.31 Per unit
Total time		4.90 Per unit

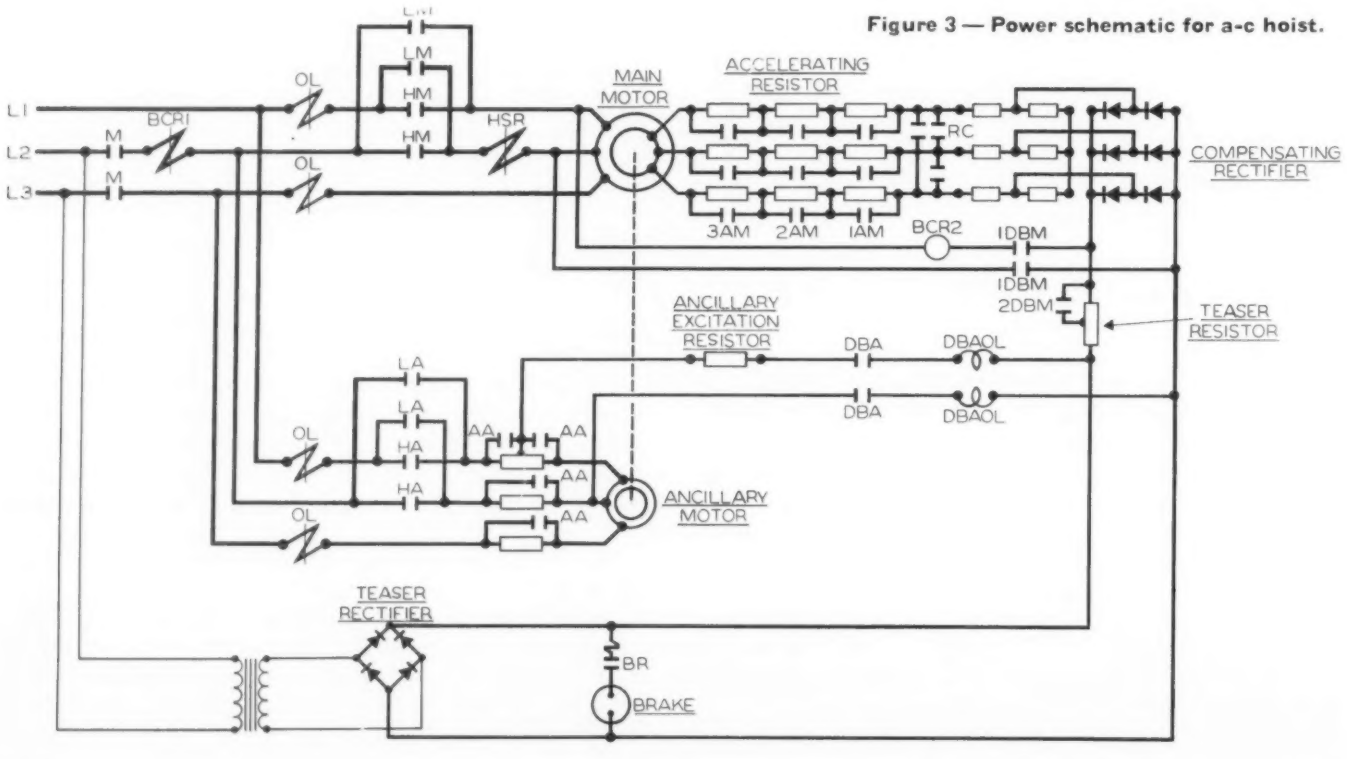
For the a-c hoist:

Time taken to raise 50 per cent load	$= \frac{1}{0.97}$	= 1.03 Per unit
Time taken to lower 50 per cent load	$= \frac{1}{1.02}$	= 0.98 Per unit
Time taken in transport and light hook movement	=	3.05 Per unit
Total time		5.06 Per unit

Consider 25 per cent load. For the d-c hoist:

Time taken to raise 25 per cent load	$= \frac{1}{1.35}$	= 0.74 Per unit
Time taken to lower 25 per cent load	$= \frac{1}{1.30}$	= 0.77 Per unit
Time taken in transport and light hook movement	=	3.31 Per unit
Total time		4.82 Per unit

Figure 3 — Power schematic for a-c hoist.



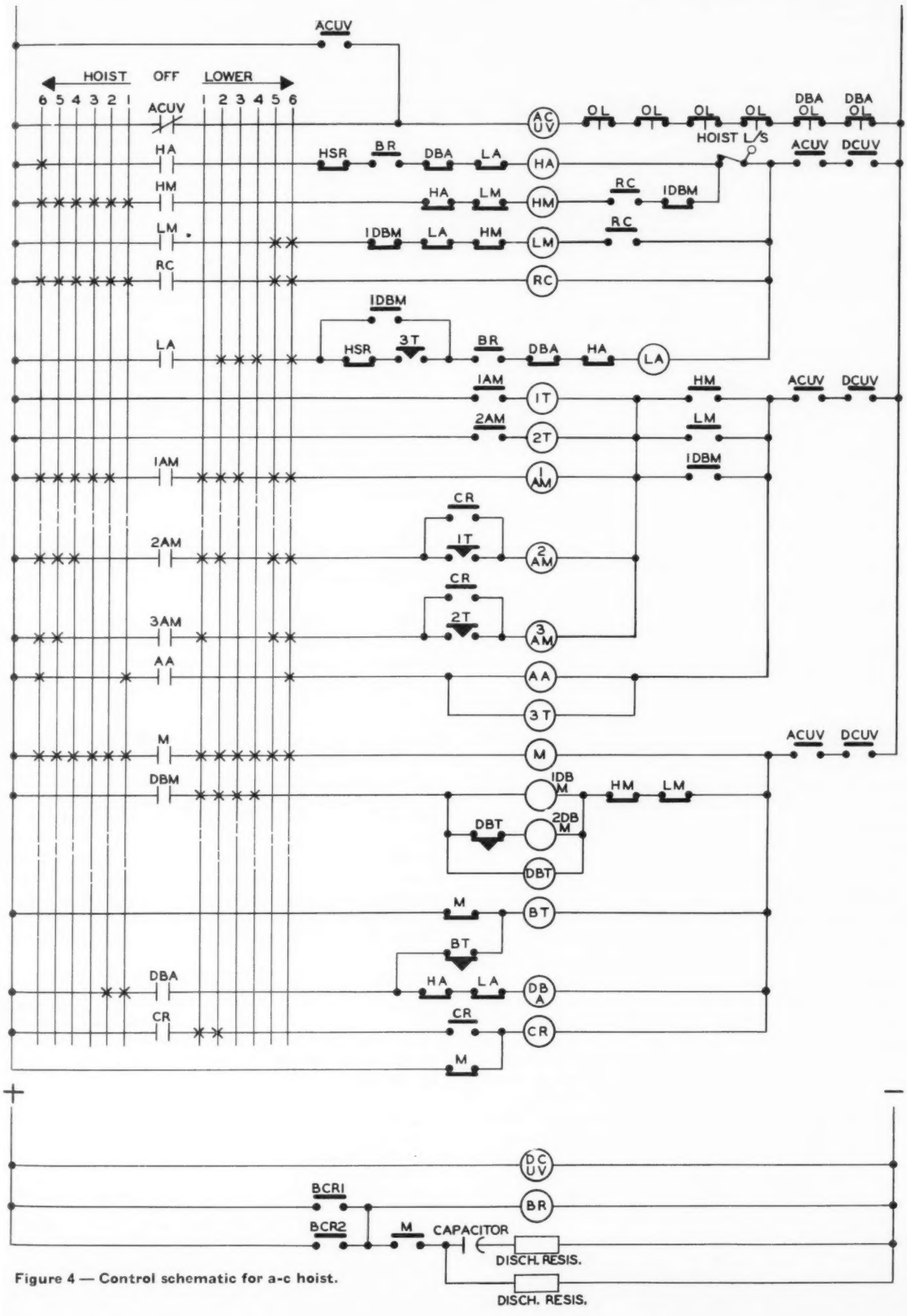


Figure 4 — Control schematic for a-c hoist.

For the a-c hoist:

Time taken to raise 25 per cent load	$= \frac{1}{1.79}$	= 0.56 Per unit
Time taken to lower 25 per cent load	$= \frac{1}{2.02}$	= 0.50 Per unit
Time taken in transport and light hook movement	=	3.05 Per unit
Total time		4.11 Per unit

In general the high speed of lowering light hook in the a-c hoist compensates for the slower speed of lowering heavy loads. Thus, it is scarcely possible to claim that the performance of either hoist is superior to that of the other.

THE A-C HOIST SCHEME

The power schematic for the a-c hoist is shown in Figure 3. One wound-rotor motor (main) and one NEMA Design D squirrel cage motor (ancillary) are required. The motors have equal horsepower ratings, but the synchronous speed of the ancillary motor is twice that of the main motor. The main motor must be rated to run at a maximum speed of approximately 225 per cent synchronous speed.

The control schematic for the a-c hoist is shown in Figure 4. There may be five or six hand-controlled points in each direction provided by the master switch. In the five-point scheme, high-speed drive is automatically obtained in the point 5 position in each direction, provided that the load is within prescribed limits. The following description applies to the six point control.

In the hoisting direction, the main motor operates under normal control by variation of rotor circuit resistance. On the first two points, the hoisting torque of the main motor is opposed by a d-c dynamic braking torque developed by the ancillary motor. On the next three points, the main motor is not opposed by the ancillary and accelerates the load up to rated full load speed for the hoist. The behavior of the load on the sixth point is governed by the magnitude of the load on the hook. If this is in excess of 40 per cent, the hoist continues to raise the load as on point 5. If the load is less than 40 per cent, the ancillary motor comes into operation and drives the load or empty hook up to approximately twice the rated full load speed for the hoist. If desired, the master switch may be moved from "Off" immediately to "Hoist 6" thus starting the load on the "Hoist 3" characteristic and improving the efficiency of the work cycle.

In the lowering direction, the main motor provides compensated d-c dynamic braking on the first four points. On the first point the ancillary motor idles, so that any lowering speed is due to the tendency of the load to overhaul the hoist and drive the main motor against its braking torque. On the next three points, the ancillary motor drives down with a torque adjusted to yield a series of speed points at all loads. Under these conditions the downward driving torque of the ancillary motor and the overhauling torque provided by the load are held by the compensated d-c dynamic braking torque developed by the main motor. On the fifth point, the main motor provides a-c regenerative braking or downward driving at the rated full load speed for the hoist. The behavior of the control on the sixth point is again governed by the magnitude of the load on the hook. If this produces regenerative currents greater than the motor currents required to hoist 40 per cent load, the hoist continues to lower the load as on point 5. If the regenerative current is less than this amount, the ancillary motor comes into operation and drives the load on empty hook up to approximately twice the rated full load speed for the hoist, holding it at that speed by regenerative braking if necessary. If desired, the master switch may be moved from "Off" immediately to "Lower 6."

A d-c operated magnetic service brake with series safety circuits in both hoisting and lowering is employed. The brake is controlled by relays BCR1 and BCR2. Failure of either a-c or d-c excitation to the motors thus causes the brake to set and switches off the ancillary motor. Loads beneath the limit imposed by relay HSR for high speed operation are safely handled by the brake and ancillary motor without the assistance of the main motor. When the master switch is returned to the "Off" position, the hoist is brought to rest by the service brake assisted by d-c dynamic braking of the ancillary motor.

In the light of the foregoing description it is apparent that the a-c hoist is the equal of the d-c hoist in safety of operation.

COMPLEXITY OF CONTROL

Here there is a danger of comparing unlike devices and merely producing confusion. It is simpler and more informative merely to compare the over-all cost of machines and control for two schemes of similar horsepower.

If an adequate d-c supply is already available, then there is little doubt that the d-c hoist is cheaper than the equivalent a-c hoist. Whether or not this would be true for the entire installation depends upon the traction requirement.

If an adequate supply of direct current is not available, then a careful study of relative cost for the entire installation and power source is called for. Included in such a study should be the question of over-all power consumption and any gains available in this respect from regeneration. Questions of maintenance, spare machines, etc., must also be taken into consideration.

In the light of such study it will be found that the choice of the d-c hoist is far from being a foregone conclusion.

SUMMARY

As stated at the beginning, this has been an attempt at an unprejudiced comparison of two types of hoist. In the light of this comparison it is submitted that an a-c hoist may be made as flexible, as efficient, as safe and under certain circumstances as cheap as a d-c hoist capable of the same service.

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TENTATIVE LIST OF PAPERS

AISE Spring Conference

AUSPICES OF ROLLING MILL COMMITTEE

SHERATON HOTEL PHILADELPHIA, PA.

April 25, 26, 27, 1960

"Hot Strip Mill Electrical Systems—Design Trends," by W. M. Krummel, Steel Mill Application Engineer, Metal Rolling and Processing Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Reversing Cold Strip Mills with Automatic Gage Control," by A. F. Kenyon, Advisory Engineer, Industrial Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"A Program for Automation of High Speed Temper Mills," by D. E. Rea, Application Engineer, Industrial Systems Dept., and R. C. Lopez, Control Engineer, Control Dept., Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

"Retaining Flexibility in the Design of Mechanized Merchant Bar Mills," by Edward C. Peterson, Vice President, Rolling Mill Equipment Div., and William H. Boblitz, Roll & Mill Machinery, Sales Engineer, Birdsboro Corp., Birdsboro, Pa.

"The Operation of a Three-Strand High-Speed Rod and Merchant Mill," by A. H. Griffiths, Superintendent of Rolling Mills, Sheffield Div., Armco Steel Corp., Kansas City, Mo.

"Investigation of Spalling of Work and Back-up Rolls in Hot and Cold Strip Mills," by J. V. Latorre, Research Engineer, and M. K. Chakko, Metallurgical Research Laboratory, Syracuse University, Syracuse, N. Y.

"Roll Wear in Finishing Trains of Hot Strip Mills," by Dr. George Sachs, Associate Director, Syracuse University Research Institute, J. V. Latorre, Research Engineer, and M. K. Chakko, Metallurgical Research Laboratory, Syracuse University, Syracuse, N. Y.

"Instrumentation for Hot Strip Mill Test Program," by N. S. Wells, Section Head—Application, Special Controls and Drives, Electrical Dept., The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"Analysis of Operational Factors Resulting from Hot Strip Mill Tests," by John S. Ride, Metallurgist, Development and Special Duties Div., Metallurgical Dept., The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

"Profit Improvement through Waste Fuel Utilization," by R. E. Leip, Utilities Coordinator, Fairless Works, United States Steel Corp., Fairless Hills, Pa.

"Investigations into Transient Temperature Distributions within Slabs Heated in Continuous Furnaces," by A. H. El-Waziri, Senior Technologist, Applied Research Laboratory, United States Steel Corp., Monroeville, Pa.

"Experiences in the Use of Electrically Heated Soaking Pits in European Practice," by Harald Bjerke, Special Engineer, Rust Furnace Co., Pittsburgh, Pa.

"Ductile Iron in Steel Plants," by C. R. Isleib, Metallurgist, Ductile Iron Div., International Nickel Co., Inc., New York, N. Y.

"Some Concepts of Mill Bearing Lubrication Employing Oil, Plastic Grease and Oil Mist," by O. G. McCandless, Lubrication Advisor, Butler Plants, Armco Steel Corp., Butler, Pa.

"Trends in Rolling Mill Drive Design," by Roger Jones, Sales Manager, Metal Producing Industries, Industrial Products Div., Western Gear Corp., Belmont, Calif., and Royal Hawley, General Supervisor, Design Engineering, Seattle Works, Western Gear Corp., Seattle, Wash.

"An Analysis of the Stresses and Deformations in Work Rolls," by Carl F. Zorowski, Assistant Professor of Mechanical Engineering, and Alvin S. Weinstein, Assistant Professor of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

"Soaking Pit Expansion and Installation of Slabbing Mill at Kaiser Steel's Fontana Plant," by M. L. Gruver, Superintendent, Blooming, Slabbing and Structural Mills, Fontana Works, Kaiser Steel Corp., Fontana, Calif.

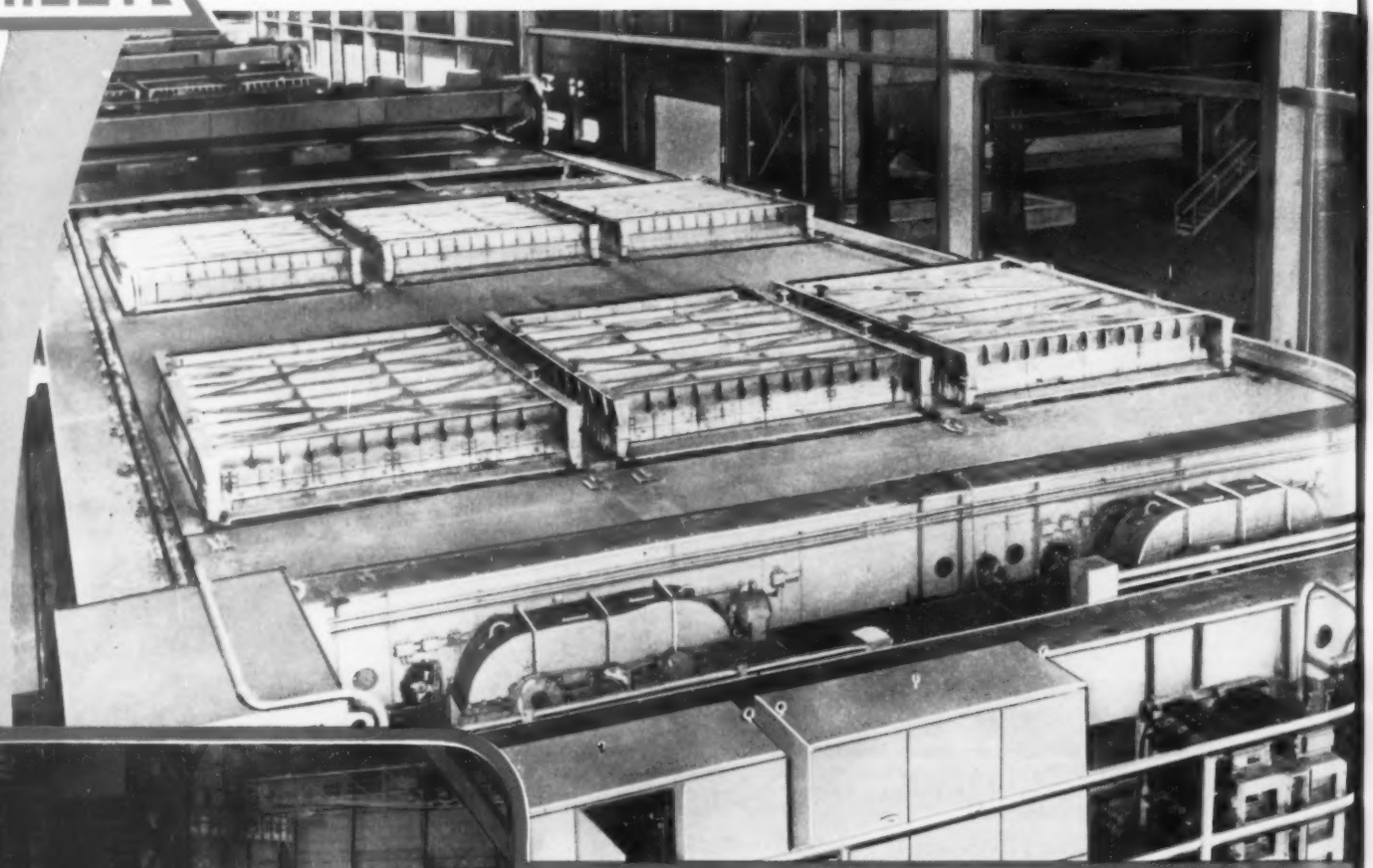
"46-In. Blooming and Plate Mill," by J. L. Laidlaw, Manager of Engineering and Construction, and J. H. Walshaw, Superintendent, 46-In. Blooming and Plate Mill, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada

OFF-THE-RECORD ROLLING MILL PANEL DISCUSSION
Fire-Cracking in Rolls

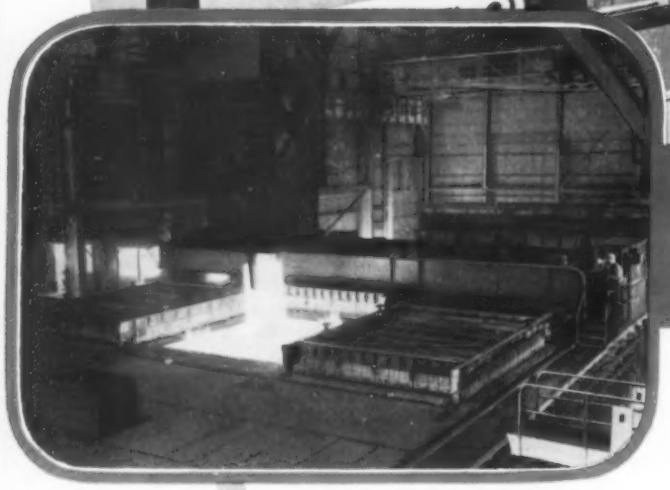
INFORMAL STAG DINNER—APRIL 26

INSPECTION TRIP—APRIL 27
Bethlehem Steel Co., Bethlehem, Pa.

Automatically Controlled Soaking Pits



NINE-HOLE SOAKING PITS designed and constructed for National Tube Division, U. S. Steel Corporation, Lorain, Ohio.



Ingot drawing at a Rust recuperative soaking pit at Lorain Works

The two-way, top-fired, recuperative soaking pits feature completely automatic temperature, fuel air ratio and furnace pressure control. Three batteries of three holes each; hole size: 12′ 6″ wide, 15′ long and 15′ deep. Constructed for Lorain Works, these soaking pits were designed to utilize Rust tile recuperators, which pre-heat air for combustion to 1300°F., resulting in increased efficiency and fuel economy.

Rust Furnace Company, serving the metallurgical industry since 1925, designs, constructs and places in operation all types of furnaces. We are equipped to meet any of your furnace requirements for melting, reheating or heat treating.

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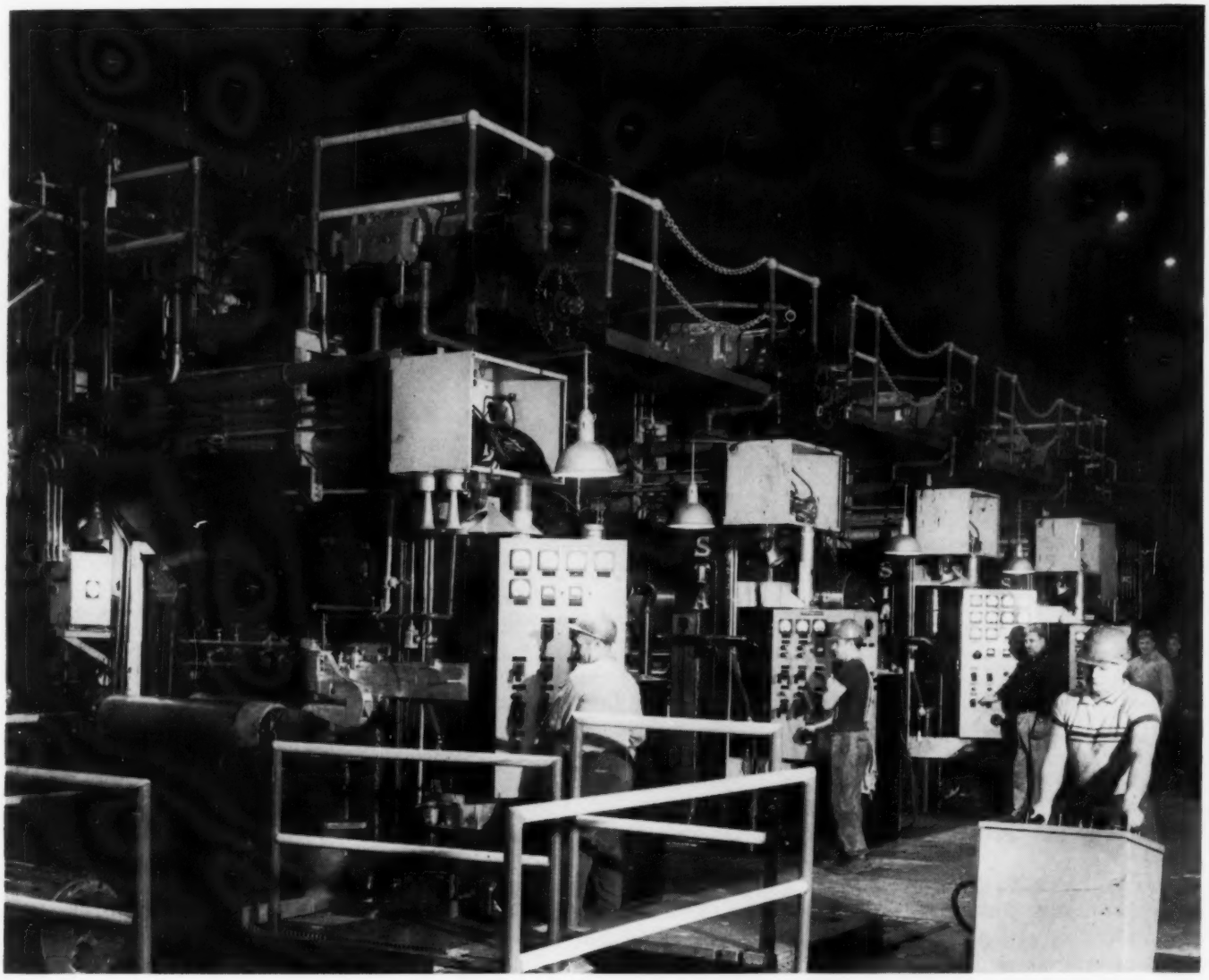


The new 4-stand tandem cold reduction mill operates at speeds of from 700 to 1400 fpm.

Weirton Starts Revamped Tandem Mill

A NEW four-stand tandem cold reduction mill was placed in operation at the end of 1959 in the 54-in. strip steel department of Weirton Steel Co. division of National Steel Corp. The new unit, designated as the No. 8 tandem mill, is an important addition to the company's facilities for the production of quality cold rolled steel. The complete design of the new mill was done by the engineering department of Weirton Steel Co. and the installation was by Weirton Steel's construction department. The new unit brings to six the number of tandem cold reduction mills in operation at Weirton.

The four-high mill, which can handle 60,000-lb coils of steel, is equipped with a coil opener of new design on the entry end of the line to make threading of coils nearly an automatic operation. This device opens the coil when it is positioned at the entry end and feeds the strip steel into the first stand, an operation which is normally done by hand.

No. 8 tandem, which operates at speeds of from 700 to 1400 fpm, can handle coils of 90 in. OD at the entry end and 84 in. diam at the delivery end, and will roll coils of from 20 to 48 in. in width. It will roll steel of 0.080 to 0.1875-in. gages, reducing it to gages of 0.015 to 0.135 in. The outside diameter of the work rolls is 18¼ in. while the backup rolls have an outside diameter of 39¾ in.

The original housing for the mill was purchased from Crown Cork and Seal Co. of Baltimore where it was used as a five-stand, for-high combination tinplate and cold roll line capable of handling widths of less than 32 in. It handled coils of 6000 lb at a top speed of 900 fpm.

Previously, each stand of the mill was operated by 600 hp, but with installation at Weirton Steel, stands No. 1 and 2 were increased to 1200 hp, and stands No. 3 and 4 were boosted to 1500 hp.

As a part of the Weirton installation, a modern oil cellar and equipment for lubrication and mixing palm oil and quasol were added. ▲

Sharon Steel Installation Cuts Order Processing Time

STEEL orders which take days to process under normal conditions soon will require only minutes, as the result of the installation at Sharon Steel Corp. of the first IBM computer system of its type in the steel industry employing complete order entry, facilities loading, scheduling, inventory control, billing and invoicing programs. Full beneficial operation is expected by mid-year.

Sharon has been programming for this computer for approximately one year. Due to the complexity of the steel business a method of feeding information to the computers has been difficult to achieve. Whereas other companies have been able to do the job in part, Sharon feels it is on the threshold of doing it in its entirety.

Sharon ultimately plans to process all paper work to adequately record all production dates, and to assemble and schedule all the orders the company may have over a given period of business. It plans to feed data to the equipment on which important managerial, sales, market research, purchasing, metallurgical, research, engineering and production decisions can be based.

Valued in excess of $1,000,000 the 14 tons of IBM equipment now installed in 3019 sq ft of working area at the Roemer Works comprises 14 separate components which are the working elements of the 650 tape-RAMAC computer.

The "Electronic Brain," which is the IBM console, has more than six thousand vacuum tubes, almost six thousand diode tubes, operates at 17 different voltage levels and has more than 3600 magnetic cores in which to store information. It generates enough heat to heat three five-room houses, and enough electricity to light 72 houses. A 90-ton air conditioning unit maintains proper temperature and humidity to prevent breakdown of the electronic circuits from excessive heat.

Programming for the computer under the department headed by Charles W. Diven, Jr., assistant to the president, has been in progress for the past year. The 650 console, heart of the installation has the capacity to read, write, perform arithemetic operations, sort, collate and summarize desired information. The system can perform 78,000 additions and subtractions per minute, and, when so instructed, can make logical programmed decisions at the rate of 2300 per sec.

Figure 1 — With this IBM computer system, including the 650 RAMAC console shown in the center of the room, Sharon Steel Corp. is processing all of the order entries, facilities loading, scheduling, inventory control, billing and invoicing programs for the entire company.

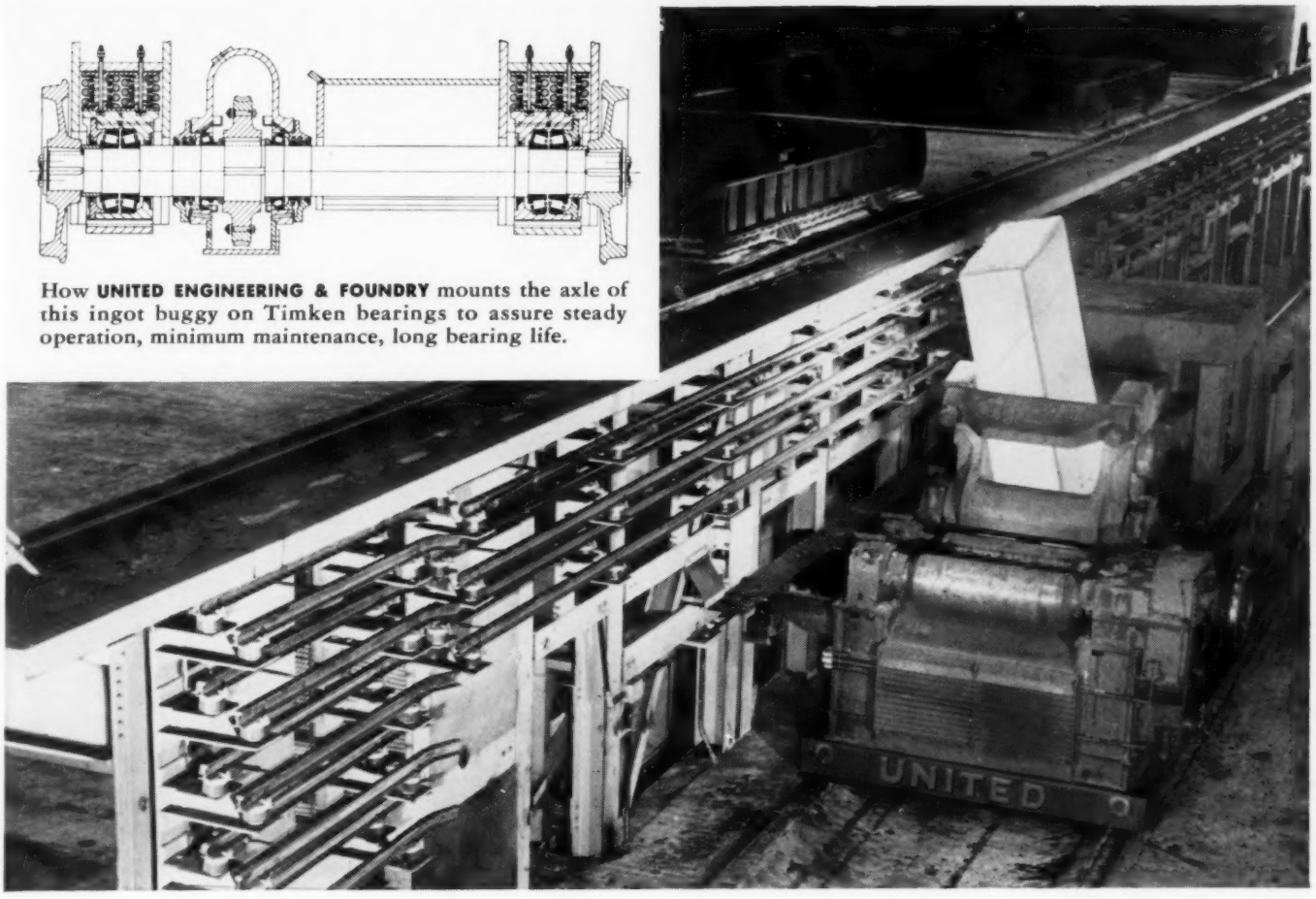
As set up at Sharon Steel, the electronic data-processing equipment is capable of operating at 112 hours per week, although in initial trial run stages no such performance is expected. In addition to the 650 RAMAC console the two primary types of electronic equipment at Sharon are the four tape drive units and the two RAMAC'S—the principal areas for storage of data and statistics.

Each tape utilizes 2400-ft tapes which hold about 4,500,000 characters written on the surface in the form of magnetic spots. The tape units can read this information into the system at the rate of 15,000 characters per second, and can put out information on the tape at the same speed.

Principal purpose of the RAMAC is to store information for rapid access. This unit consists of 50 rotating disks, 24 in. in diam, rotating at 1250 rpm. One unit will hold 6,000,000 digits of information and any of these 6,000,000 digits can be reached in a fraction of one second. Information is read from and written onto these disks by three access arms that move independently of each other. These units provide the system with tremendous flexibility, the ability to reach stored facts directly without having to search through unwanted information.

When a new order is received it is first sent to the metallurgical department to determine the method of processing the steel. This usually requires three days. Thereafter a customer product record is key punched and added to the file on magnetic tape. Then an order item card is punched which gives the date of purchase order, Sharon's file reference, quantity ordered, date requested and other pertinent data. This card then is fed to the computer. The computer searches the file and produces the multilith mat required to process the order, along with the customer acknowledgment. ▲

How **UNITED ENGINEERING & FOUNDRY** mounts the axle of this ingot buggy on Timken bearings to assure steady operation, minimum maintenance, long bearing life.



Keeps hot slabs moving fast with 27 Timken® bearings to keep it rolling

THIS United ingot buggy moves hot slabs and keeps 'em moving fast from a major steel producer's slab mill. To make sure the buggy moves the heavy loads steadily, with minimum maintenance, its builders, United Engineering & Foundry, equipped it with 27 Timken® *tapered* roller bearings. They're used on the axle drive worm shaft, axle journals, worm gear tilting drive worm shaft and tilting drive pinion shaft.

Timken bearings keep shafts aligned, gears meshing accurately. The tapered design of Timken bearings enables them to take any combination of radial and thrust loads. And full-line contact between rollers and races provides maximum stability. Cost-saving results are: shafts are held rigid; gears mesh smoothly and accurately; shaft wear is eliminated; gear wear reduced.

Any machine with Timken bearings gives you *extra* benefits—the benefits of Timken Company leadership in tapered roller bearing design and in engineering service. It's leadership backed by the most modern research and development facilities in the bearing industry. To get the most out of the machines you build or buy, specify Timken bearings. ***When you buy Timken bearings you get . . .*** *1) Quality you can take for granted. 2) Service you can't get anywhere else. 3) The best-known name in bearings. 4) The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

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Machinecraft gets .0005" tolerances with Cities Service Chillo Cutting oils!

Machinecraft, Inc., of Whitman, Massachusetts, makes a product that is surely the answer to many a textile man's fondest wish.

In place of old-style solid arbor top rolls, which often drip lubricant onto the fabric, Machinecraft has developed "the anti-friction top roll."

Operating on ball bearings, this unique invention requires almost no lubrication, therefore eliminates staining problems. In addition, it permits higher speeds of operation and produces more uniformly woven fabric.

In all of this, extremely intricate machining is required —and Cities Service Chillo Cutting Oil plays a crucial role.

Using Cities Service Chillo "A," Machinecraft is actually achieving tolerances as fine as .0005"! Moreover, Machinecraft reports that Chillo "A" gives "excellent tool life, produces a fine finish, has unusual stability, and offers continuous quality from batch to batch."

"In addition," continues this well known firm, "Cities Service provides us with exceptional technical assistance and good delivery service."

There's little to add to what Machinecraft says except a reminder that *you* can expect similar results with Cities Service, too. Talk with a lubrication engineer from the nearest office. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

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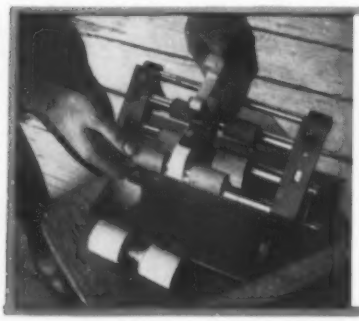
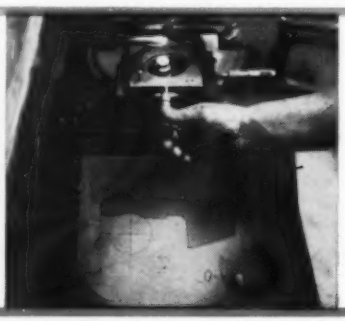
QUALITY PETROLEUM PRODUCTS



Machinecraft's Anti-Friction Top Roll is rapidly replacing old-style solid arbor type top rolls in textile mills. It prevents staining, permits greater operating speeds.



Shadowgraph is method of checking accuracy of precision machined parts for anti-friction top roll. Machine magnifies and projects the part's shadow outline. Tolerances are as fine as .0005".

Titanium Heat Treat Process Gives High Strength In Light Gages

DEVELOPMENT of a superior heat treatable titanium sheet alloy along with a new process for heat treating have been announced by Republic Steel Corp. The new heat treated titanium sheet is described as particularly attractive to the aviation industry, since it can be utilized in thinner gages, and therefore lighter weight, while still holding to required strength ratings.

The heat treatable titanium alloy is identified as Type RS-140. Now commercially available from Republic's Alloy Steel Division, Type RS-140 contains 5.0 Al-1.25 Fe-2.75 Cr. This grade is supplied in the fully heat treated condition in sheet gages as light as 0.010-in. and in sheet sizes up to 48 x 120 in. Fully heat treated RS-140 titanium alloy sheet with strengths in excess of 190,000 psi are being supplied on a commercial basis.

Areas in which heat treated titanium such as RS-140 can be utilized in aircraft or missiles include skins, stiffners, internal structures, engine nacelles, bulkheads and as heat shields. Another area in which heat treated RS-140 offers a substantial weight savings over other materials is for cover sheets on honeycomb sandwich type panels.

The new process for heat treating large titanium sheets makes it possible to produce heat treated titanium alloy sheet free of surface contamination with better flatness and more uniform properties than ever before. The new process was developed primarily for RS-140, but it may be used for other heat treatable alloys as well. Other alloys which have been successfully heat treated by Republic include Type RS-120A (6.0 A1-4.0 V) and Type RS-115 (4.0 A1-3.0 Mo-1.0 V). The commercial availability of heat treated titanium alloy sheet made possible by this new process, it is stated, will provide the aircraft designer with a material having a strength to weight ratio greater than any other material currently being used in aircraft construction.

In suggesting that these new developments represent an important advance in expanding the use of titanium in aircraft and missile applications, Republic Steel's titanium metallurgists state that one of the shortcomings in the past has been the lack of suitable titanium alloys which were capable of being heat treated to high strength levels.

For its new heat treating process, Republic Steel is using a five-zone electrically-heated continuous roller hearth furnace, especially adapted to deliver uniformly heated sheets directly into a continuous roller quenching unit. This furnace is described as providing for a high degree of uniformity of heating, with temperature control in each zone of plus or minus 10 F.

In the heat treating process set up by Republic, titanium sheets which have been specially precoated to prevent contamination by atmospheric gases are heated for short periods at a temperature between 1400 and 1700 F depending upon the alloy grade. This is followed by water quenching in a continuous roller quenching unit. Sheets treated with the Republic Steel coating can be cleaned without immersing in molten caustic, the conventional method used to descale titanium.

After being treated the sheets are in the soft condition and may be either hot or cold formed, then "aged" for several hours at a temperature between 900 and 1000 F to produce high strength levels. Alternately, it is explained, the sheets after solution treating may be aged at the mill, then shipped in the fully aged condition for applications where only moderate forming is required, but where high strength is necessary in the final part. ▲

Figure 1 — Delivery of heated titanium sheet to fixtured spray quench operation. Quenching operation is one of a series of steps in the new Republic Steel procedures for thin titanium sheet.

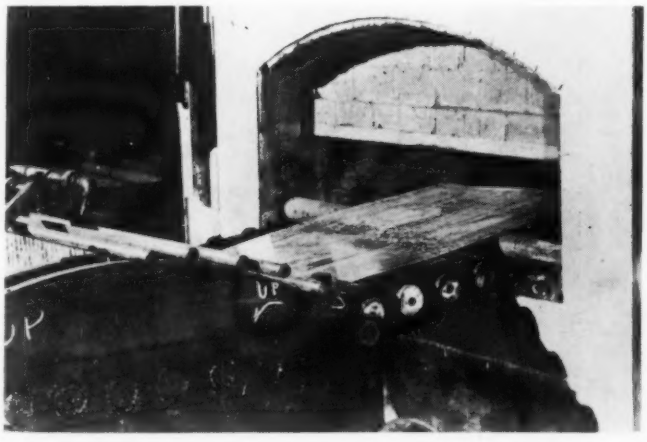
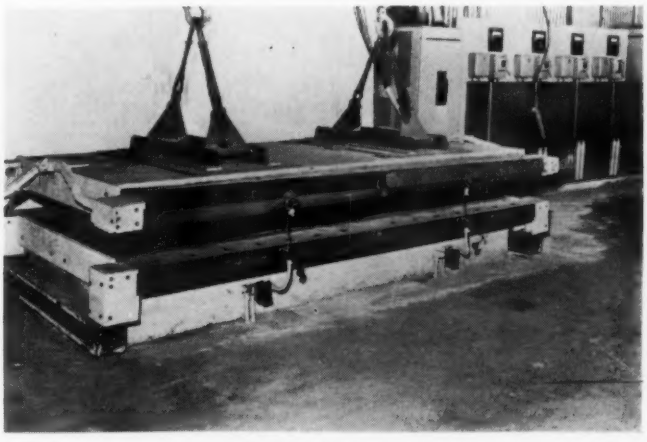


Figure 2 — Electric platen aging equipment can handle sheets up to 48 in. wide by 120 in. long and serves the two-fold purpose of uniform aging and flattening.



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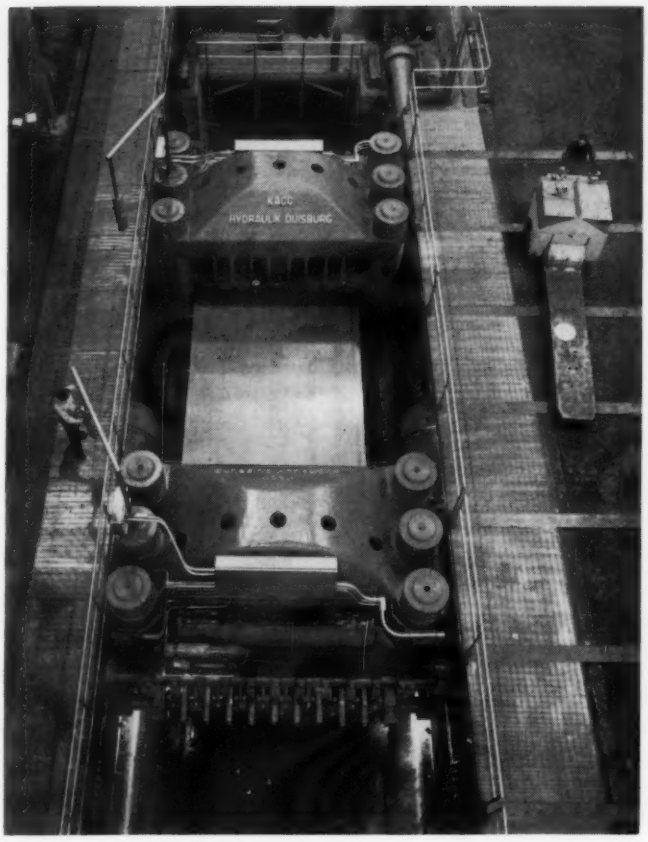

Figure 1 — The 30,000,000-lb plate stretcher will refine the internal structure of the metal by equalizing stress distribution.

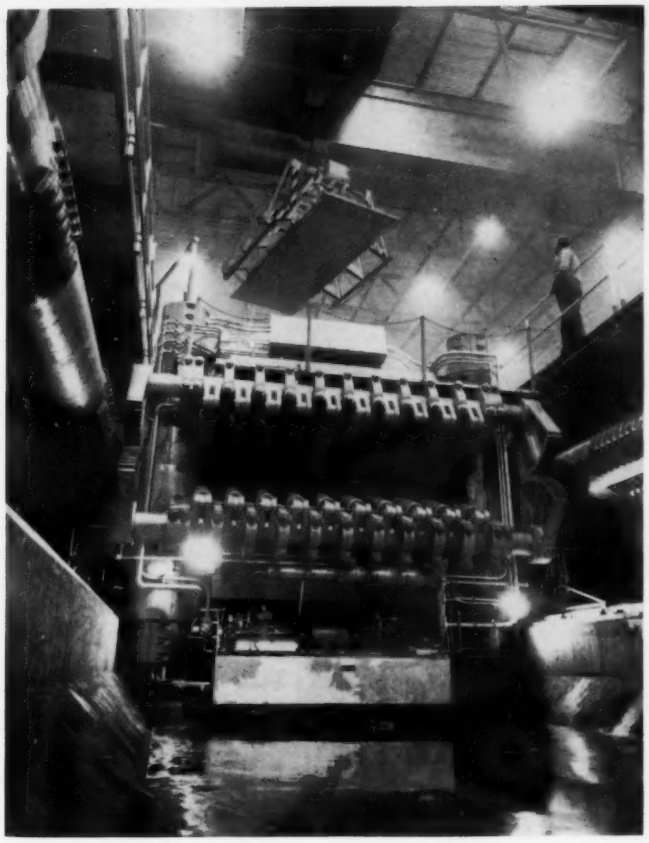

Figure 2 — Rear portions of the gripping mechanism on the 30,000,000-lb machine are capable of handling aluminum plate up to 6 in. in width and 60 ft in length. Overhead crane is lowering plate into position.

Kaiser Installs Large Plate Stretcher At Ravenswood Works

A MASSIVE machine capable of gripping the ends of a 60-ft long plate of thick, high-strength aluminum and stretching its length by as much as four feet has been put into operation at the Ravenswood, W. Va., Works, of Kaiser Aluminum & Chemical Corp.

The plate stretcher—installed in a concrete pit 120 ft long, 32 ft wide and 15 ft deep—possesses a pulling force of 30,000,000 lb, or nearly twice that of the largest stretcher currently in the metals industry. It can handle aluminum alloy plate up to 6 in. thick and 13⅓ ft wide, within an over-all cross-sectional area limit of 640 sq in., as compared with the previous industry maximum of about 350 sq in.

Purpose of the stretcher is to refine the internal structure of the metal by equalizing stress distribution in heat treated alloys and welding alloys that are gaining increasing use in a wide variety of industrial and structural applications.

Unique features of design have made it possible to create a stretcher of this size weighing less than 3,000,000 lb. The machine is built without a supporting or guiding frame. Although power cylinders and columns are in compression, the machine is free to move on a track with no effort being made to hold it in rigidly fixed alinement.

A pair of large stretching cylinders—designed for 4½ ft of stroke—are used only during the high pressure portion of the stretching cycle and remain idle during the manipulating cycle when loading and unloading the machine occurs. Manipulation is accomplished by a pair of double-acting cylinders with extra large double ended rods. These double end rods provide a means for control of flow of oil in the circuit and eliminates much of piping and flexible connec-

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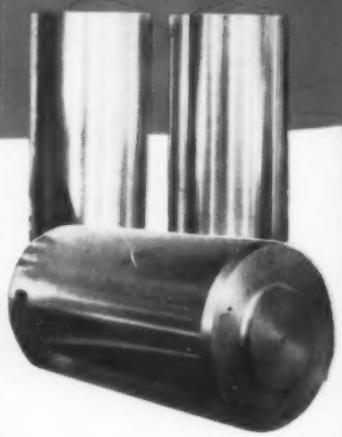

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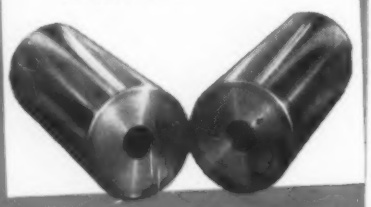

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tion used in conventional equipment of this type.

The advanced features of the oil system also eliminate the necessity for large piping or prefill valves common to hydraulic equipment which operates unloaded through long traverse strokes.

Motion of each side of the machine is controlled from four high pressure variable volume pumps driven by two 300-hp motors. Equal volume is delivered to each side of the machine operating a manipulating cylinder and a stretching cylinder. The machine's motion is controlled by moving these pumps through center to forward and reverse with the amount of movement of the mechanism on the pump regulating the speed of travel.

The maximum speed of stretching is approximately 1 fpm and the maximum speed of manipulating is 20 fpm. The pumps on each side of the machine are connected so that it will remain parallel at all times regardless of whether plate is placed in the center of the jaw and regardless of the load on each side of the machine.

Construction of the heads for the machine created unusual manufacturing problems. Instead of the conventional "C" frame type design, the stretcher has an open back design. This design was selected because depth of the throat of a "C" frame head would create stresses which would be excessive and deflections which would be detrimental to jaw alinement. Heads for the stretcher consist of a top and bottom portion held together at the ends by six tie rods which are shrunk in place leaving the back open.

The jaws of the stretcher are arranged in such a way that an initial pressure is created in the plate which is capable of removing any normal transverse bow before stretching begins. Sufficient flexibility is built into the jaw to compensate for head deflection and reasonable inequalities with thickness of the plate.

The columns of the stretcher are arranged to be adjustable to a minimum work length of 17 ft and to a maximum of 60 ft. The manipulating cylinder creates all forces required to adjust the heads for the various lengths of plate being stretched.

The greatest forces encountered in a stretcher of this size are ones which must be absorbed when a plate breaks with the stretcher operating near full capacity. The most difficult stresses with which to deal are those built up within the plate and those stored in the compressibility of the oil in the system.

Since the large cylinders are used only during the stretching cycle, the maximum volume of oil under pressure in the circuit occurs at that time. Means have been provided to allow this oil to bypass at high pressure, allowing the heads to "explode" apart for a distance great enough to use up this energy.

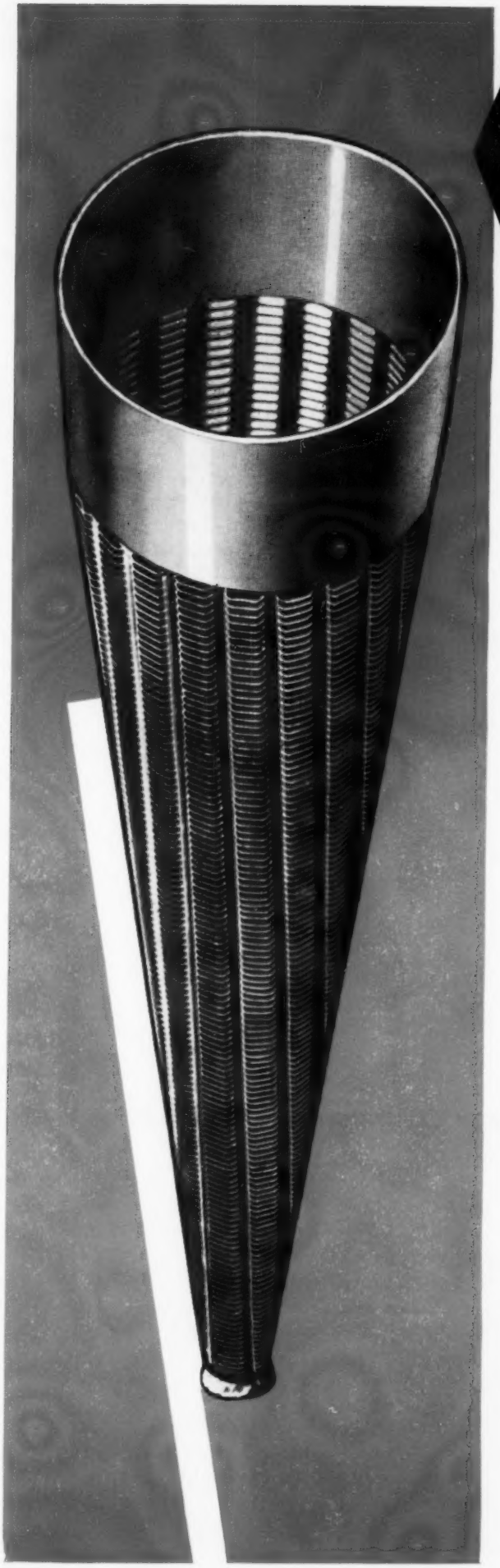
Since the stretcher is free floating on the foundation, a break conceivably could first occur on one side of the plate allowing the release of pressure on one column a small fraction of a second before pressure is released on the other and causing the stretcher to move out of alinement. Shock absorbers are provided between the foundation and the end of the column behind the stretcher to absorb part of the energy of the moving heads and to realine the stretcher in a square position.

The energy within the plate is dissipated by two means. With the jaws locked on the plate, a break will cause the jaws and plate to move apart as a unit. Shortly after the plate moves back into the jaws, they will release their grip through wedging action, with the plate flying free through the open rear of the heads. The movement of the broken plate will be absorbed by an outside bumper.

When a plate breaks, the energy which has been transmitted into the jaw before it has released its grip on the plate is the most difficult with which to deal. The stretcher jaw mechanism has incorporated into it a hydropneumatic system very similar to the recoil apparatus on an artillery piece. This system is capable of absorbing more than 15,000,000 ft-lb of energy in each head.

The pin, linkages and cylinders on the equipment have to be correspondingly sized for this energy absorption. The design relies on the slight compressibility of oil to be the device which removes the initial shock wave from the system.

The plate stretcher was built for Kaiser Aluminum by Hydraulik GmbH of Duisburg, Germany. ▲



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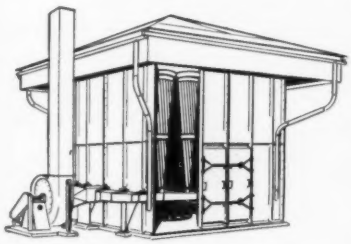

AERODYNE Dust Collectors are also used to clear combustion air for gas turbines. Oil bath and other types of filters requiring constant maintenance are eliminated by AERODYNE, as the collected dust is returned to the atmosphere. Dust disposal problems are eliminated.

You, as did Inland Steel, will find this cost-cutting story of interest. A word to Green will bring you the details.

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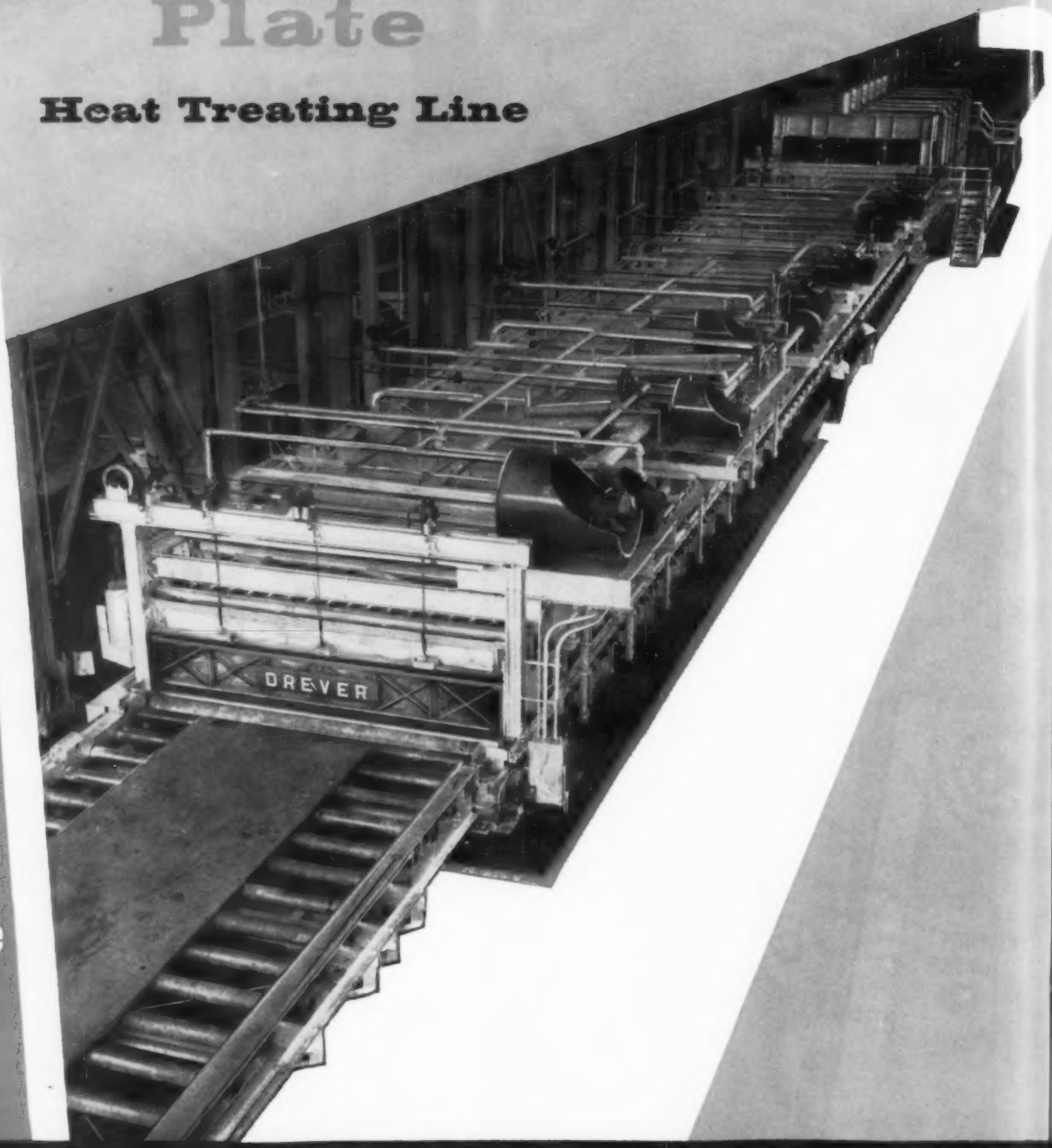
DREVER

Plate

Heat Treating Line



Shown is the charging end of a 145'-0" hardening furnace. In the background can be seen a 2500 ton pressure quench, 200'-0" draw furnace and the operator's control pulpit.

This roller-hearth plate heat treating line, known to be the largest of its type, has a capacity to treat plate up to 21-1/2 tons per hour. The equipment is capable of handling plate sizes up to 172″ wide x 3″ thick x 600″ long.

The furnace rolls are 25/12 modified alloy and are designed for a maximum furnace operating temperature of 1650° F.

The maximum fuel capacity for both furnaces is 122,000,000 Btu's per hour.

The entire line is under the control of a single operator. Full utilization of strategically located TV cameras enables the operator to have full control over all operations.

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Pilot Plant Studies New Direct Reduction Process

IN a pilot plant at Indianola, Pa, Swindell-Dressler Corp. of Pittsburgh is developing a unique method for reducing iron ore directly into pig iron.

Called the "Orcarb" process, it utilizes the company's experience in ceramic kilns plus steel mill engineering and construction.

There are three basic steps in the process: (1) the agglomerates of ore, low temperature coke and flux are prepared, (2) the prereduction of the ore takes place in a rotary kiln; and (3) the material is smelted in an electric furnace.

Advantages of the process are the following:

The capital cost is less than half that of corresponding facilities using the standard blast furnace. Production costs of the two are about the same.

The Orcarb process requires only half as much carbon from high volatile coal as the standard blast furnace. There is an intimate contact of carbon with iron ore and flux in the pellets.

The process utilizes the finest ores. It can handle ore fines or concentrates from pea size to sizes as fine as face powder.

A further advantage results from the prereduction in the rotary kiln. Reduced material entering the electric furnace from the rotary kiln has 80 per cent of the total iron in metallic form. As a result of this high prereduction, the electric furnace has used less than 1000 kwhr to produce a ton of pig iron.

The pilot plant is now open for inspection.

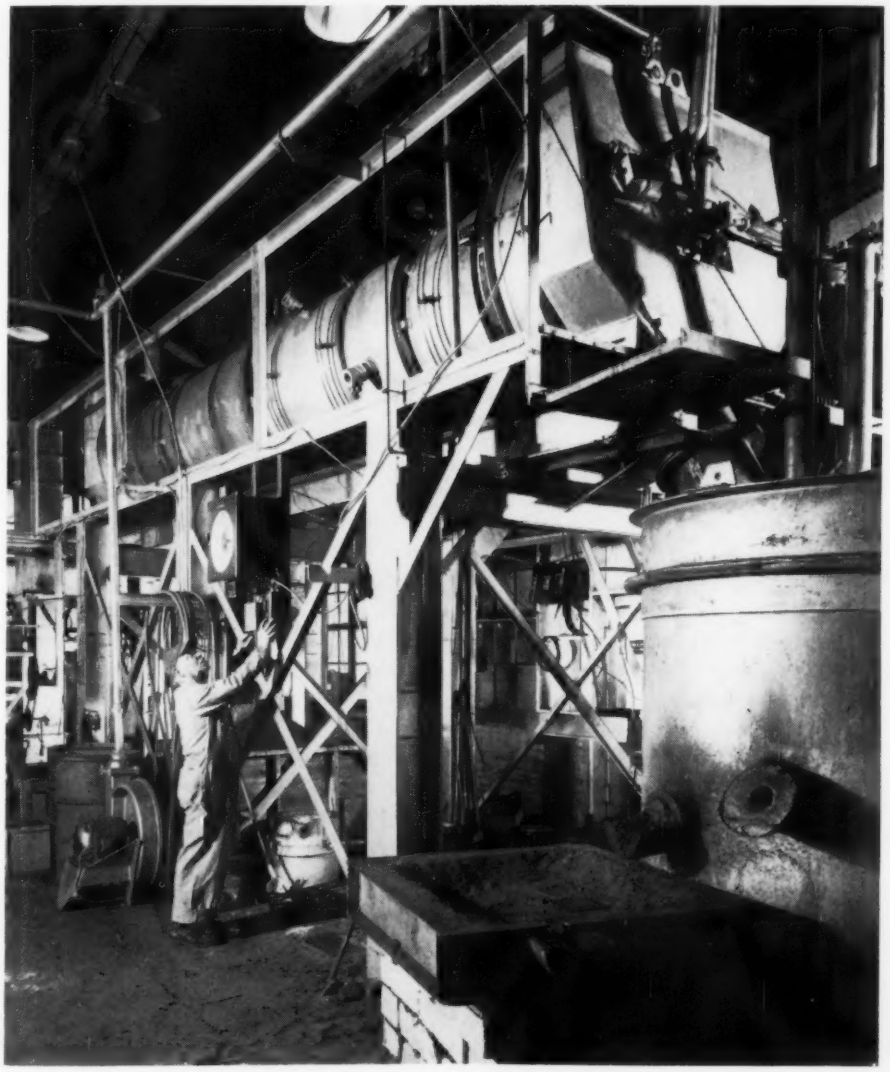
An incentive for development of the process is the relatively low capital cost of plant. Estimated cost of complete facilities using this process is about half that for coke ovens, pelleting or sintering and blast furnace. Capital costs of conventional blast furnaces have increased as the economic size of units has increased to 2000 or more tons of metal a day. The electric furnace with prereduced ore promises to be economic and competitive even with units of but a few hundred tons of pig iron per day.

This paper represents a summary of the first six months of operation.

The Orcarb unit at Indianola consists of a rotating 3 by 12-ft direct-fired kiln in which the ore and flux are preheated to about 1100 F, followed by a mixing device in which the hot ore is mixed with −4 mesh high volatile coking coal. The mixture, at 600 to 700 F, is fed continuously into an unlined steel retort revolving at a peripheral speed of 80 to 90 fpm. In this retort the coal becomes plastic, picks up the ore, is rolled into pellets, hardens to low temperature coke at about 950 F, and is discharged to the reduction kiln. Sensible heat in the preheated ore, supplemented by indirect heating through the shell of the retort, carbonizes the coal. Coking time in the retort is from 10 to 15 minutes.

Reduction of iron oxides, first to FeO and then to metallic iron, takes place in the rotating reduction kiln under proper temperatures and in the presence of carbon. The reactions are well known, the conditions well established and procedures published. The important variables are temperature and time, with accompanying excess of CO and, of course, size of ore particles. Combustion of the CO, supplies the heat for the reduction reactions. In the rotary kiln the iron oxides in a fairly deep bed of Orcab heated to temperatures between 1700 and 1900 F for an hour or more, are

Figure 1—Material flows directly from reduction kiln into electric furnace.



For accurate reproduction of bulk material formulations—W-C BATCH-WEIGHING SYSTEMS

In any batching operation—from simple dump-and-fill weighing to multi-ingredient ratioing — W-C Batch-Weighing Systems provide the reliably accurate net-weight control essential to consistent product uniformity.

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W-C

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substantially reduced to metallic iron.

The reduction kiln at Indianola is 2.5 ft inside diameter by 20 ft long, with 6-in. refractory lining. Provision is made for sampling kiln gases and material in progress at points along the length of the kiln. Temperatures at several points are recorded. Retention may be varied from one and a half to three hours. With maximum temperatures of 1800 to 1850 F, there has been no ringing or building up of the reduced charge material.

Prereduced Orcarb flows into the electric furnace through a connection in the roof, through which gases from the furnace flow countercurrent into the kiln. The furnace hearth is 2.5 ft in diam, or about 5 sq ft, has three 4-in. graphite electrodes in triangular position. Operation is normally at 60 volts, although high voltages are available and have been used. The furnace is tapped at intervals and metal is cast either in a ladle or in sand. Although transformer capacity is rated at 200 kva, the average input to the furnace is but 60 to 80 kw.

Ore used in this pilot plant during these tests was magnetite concentrates, less than 5 per cent +28 mesh and nearly half −100 mesh. On a dry basis this ore analyzed 65 per cent iron, 6 per cent silica, with traces of phosphorus, titanium oxide and sulphur. Pittsburgh bed high volatile coking coal, 6 to 7 per cent ash and about 1.5 per cent sulphur, crushed to −4 mesh was charged with the ore and flux to the Orcarb retort.

For a pig iron with 3 to 4 per cent carbon the ratio of coal to ore charged is adjusted to give 16 to 17 per cent total carbon (determined by combustion) in the pellets of ore, flux and low temperature coke. With the 65 per cent Fe ore used in these tests, the percentage of iron in the Orcarb is about 44. Total carbon in the reduced kiln product is then from 7 to 9 per cent, and iron 60 per cent. Limestone and dolomite flux has been charged to give a slag with basicity of 2. The flux, 70 per cent limestone and 30 per cent dolomite, was screened to pass 4 mesh.

Hot metal with very low carbon and silicon (0.36 per cent C, 0.01 per cent Si, S plus 0.5 per cent) was made in one test in which carbon in the furnace feed was 4 per cent or less.

It should be observed at this point that the testing is not sufficiently advanced or the data thus far available adequate to warrant definite conclusions on control of hot metal analysis. However, the experience here parallels that of others in that with a given slag volume and analysis, hearth temperature and available carbon are the variables to be controlled.

With carbon between 3 and 4 per cent and silicon between 2 and 2.5 per cent sulphurs in extended tests have averaged less than 0.03 per cent.

Reduction of the oxides of iron prior to charging the ore to the electric furnace is the key to low power consumption. At the Indianola plant, the product from the reduction kiln as it flows into the furnace is sampled once an hour. The sample, about 0.5 lb, while at temperature is contained in a steel tube, sealed from the atmosphere and rapidly cooled. A portion of the cooled sample is pulped for determination of percentage reduction in the plant laboratory.

The objective here is 80 per cent reduction to metallic iron and this has been achieved. However, the average is 75 per cent. As analytical controls have been developed and operating personnel trained in their use, reduction kiln and electric furnace results have steadily improved.

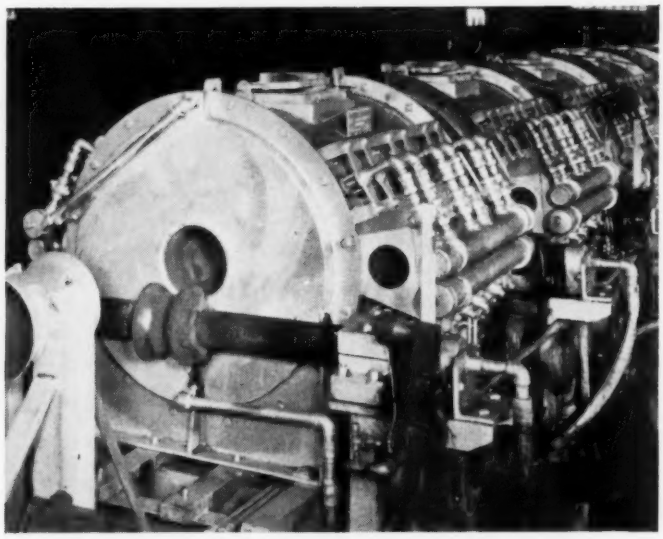
Power cost, whether 5 or 9 mills, is a very important item in the economics of electric smelting of pig iron. The difference of 100 kwhr may mean a dollar difference in the cost of a ton of metal. The data obtained in the preliminary work at Indianola indicate that the aim of substantially less than 1000 kwhr per ton of metal is attainable, using the fine ore and reactive coke intimately bound in the Orcarb pellet. Calculated power for smelting ore prereduced to 70 per cent metallic, is about 500 kwhr per ton. In a furnace with over-all efficiency of 80 per cent, this would represent between 600 and 700 kwhr per ton of metal.

It is the purpose of the work at Indianola to demonstrate the process and to establish, so far as possible with this small unit, the economic value of direct reduction. ▲

Electrode ports of this electric furnace roof are formed of B&W castable. B&W Kaocast or Kaocrete-32 can be successfully used, depending on severity of service.

High thermal release burner block is cast of B&W Kaocrete-32. Both Kaocrete-32 and Kaocast are used for burner blocks and other services in many other furnaces.

Nose arch of walking beam type furnace for heating forgings is made of Kaocast, B&W's 3000 degree castable. Kaocast is also used in forming complete forging furnaces.



This high speed barrel type heating furnace is typical of many which are completely lined with high temperature B&W Kaocast.

How B&W refractory castables solve high temperature problems

The higher temperatures in industrial processes have called for refractory castables that will stand up in these severe services. B&W offers two extremely durable, high temperature refractory products—Kaocrete-32 for applications up to 3200 F, and Kaocast with a 3000 F use limit. Both have high strength, unusual volume stability and excellent resistance to spalling and slag attack. Investigate B&W *specialized* refractory castables for solutions to your high temperature problems.

B&W Bulletin R-35A gives additional information on versatile B&W refractory castables. Write for copy to The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N.Y.

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Continuous Cycle Furnace Provides Better Grain Structure

by A. G. Sturrock, Chief Metallurgist, Wyckoff Steel Co., Chicago, Ill.

THE microstructure of the steel is the most important factor in the machinability of cold drawn steel bars. Although many other factors are involved in the machining, such as tooling, cutting oils, operator, machines and others, the fact still remains that structure is fundamental. Other machinability factors can be changed or adjusted when they are wrong, but without the proper structure, maximum machinability cannot be obtained.

From the standpoint of material alone, the machinability problem reduces itself to three main factors; uniform structure from the mill, knowledge of the customer's requirements and repetitive reproduction of the structure with heat treatment according to specification.

The Wyckoff Steel Co. had been meeting these requirements for many years, by laboriously annealing in two batch furnaces. Recently, a continuous roller hearth, cycle heating and cooling furnace has been installed to do the job more efficiently and at higher production rates.

The cycle heating and cycle cooling furnace was installed at the company's Chicago plant. The furnace, 70 ft long, was built and erected by Surface Combustion Corp., Toledo, Ohio. By combining continuous high production with automatic control, better heating and cooling accuracy has been obtainable, resulting in greater and more complete control over the uniform structure of the bars.

Work is always under the protection of accurately controlled RX generated and natural gas, or low combustible-high nitrogen NX generator gas. Carbon potential can be maintained in the furnace to provide a neutral or carbon restoring atmosphere. Bars processed through this furnace are scale-free and the surface chemistry is uniform with the body of the bar. Because the bars are spread across the rollers of the hearth in a thin layer, often only one layer deep, heating and cooling is fast and accurate, providing uniform structure and hardness for the length of the bar and across the entire load.

An important feature of the cycle heating and cooling furnace is the ability to restore carbon to bars that have been decarburized during hot rolling operations. Here again, accurate control of heating conditions and atmosphere potential made possible by the design of the furnace and automatic atmosphere control, provides proper conditions for replacing carbon in the decarburized surface of the bars. This is especially important where bars are used for products that must be induction hardened on the surface without machining certain areas of the original surface.

The furnace operates automatically except for loading and unloading. A 40-ft roller charge table and a 40-ft roller discharge table is provided for easy charging and discharging of the work. The furnace heats to 1600 F, and cools 4000 lb of work per hr with a minimum of manual attention. Temperatures of 1800 F can be attained in the furnace. Two men operate the furnace, one at each end.

Work travels through the furnace on 35 nickel-15 chrome alloy rollers that extend through the side walls of the furnace and are mounted on water cooled bearings. They are power driven through sprocket and chain drives, synchronized with the charge and discharge table rollers. The chains are driven through variable speed transmissions to provide proper speeds of travel for cycling the various size of loads. Rollers are flanged to prevent work from striking the furnace walls.

To provide flexibility of cycles, the furnace has six separate chambers. The first two are usually used for heating, the third, fourth, fifth and sixth are used for either heating or cooling. Heating is accomplished through a series of "W" type radiant tubes placed above and below

Figure 1 — The 150-ft cycle heating and cooling setup extends across three bays. Bars enter one bay and exit another. This installation acts as a transfer unit as well as a continuous furnace.

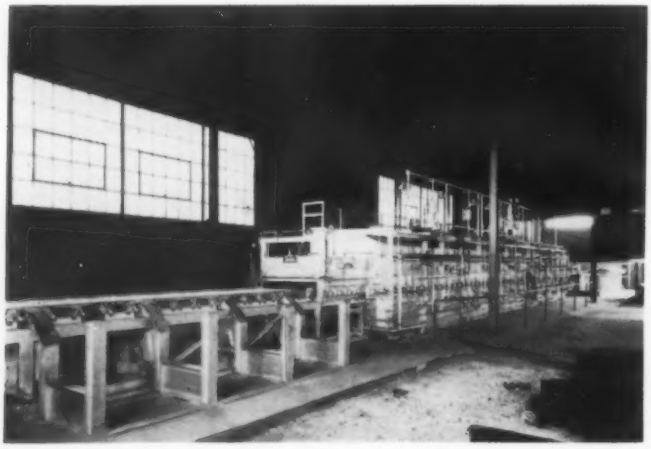
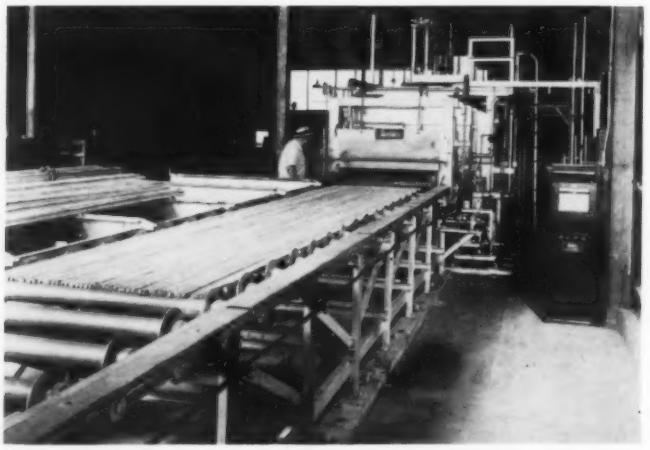


Figure 2 — Charge table is loaded with a single layer of bars. Flanged rollers keep the bars from hitting the sides of the furnace. Operator has opened the door higher than normal for this loading to show the alloy sheet atmosphere baffle curtain.



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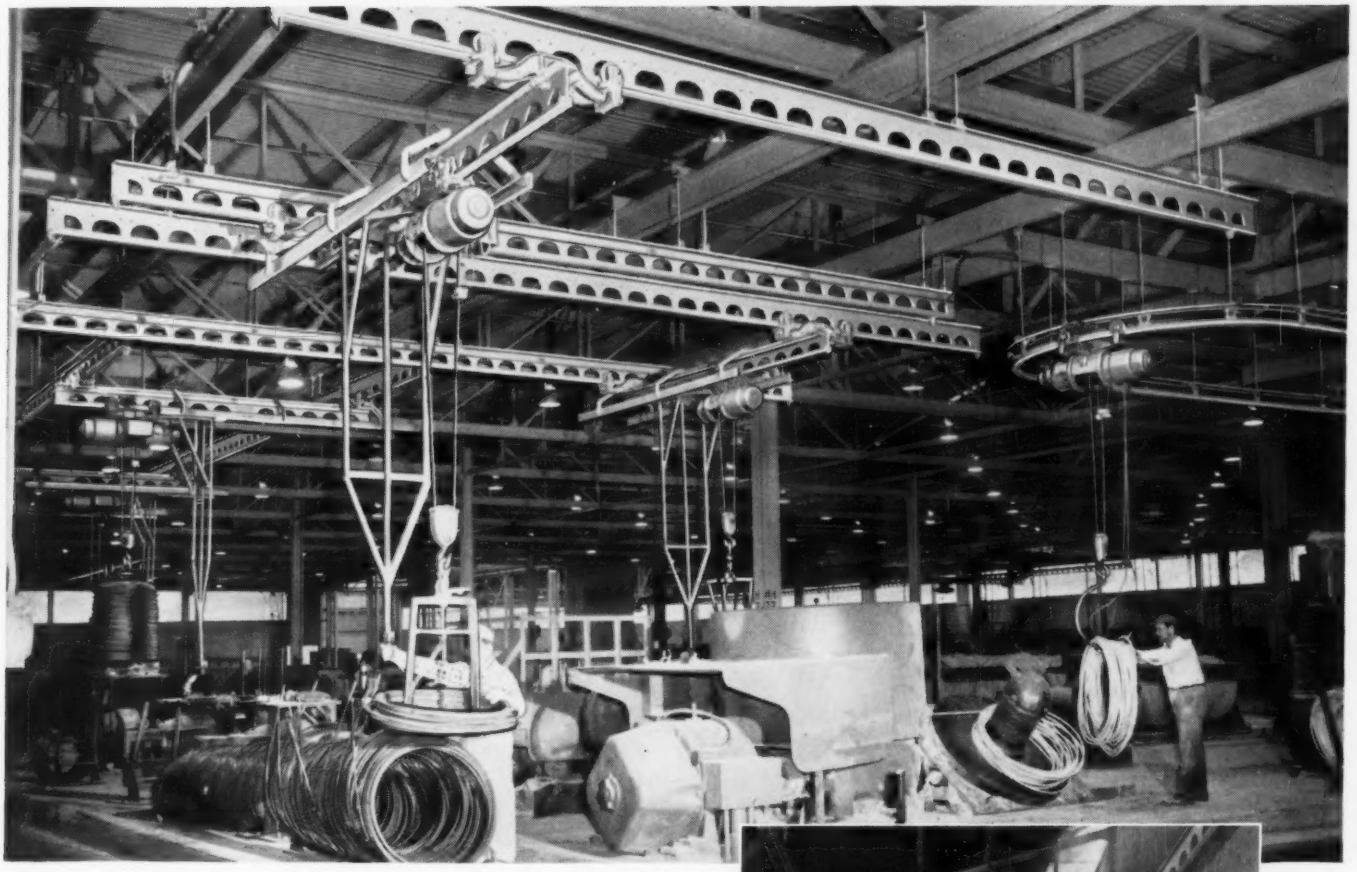
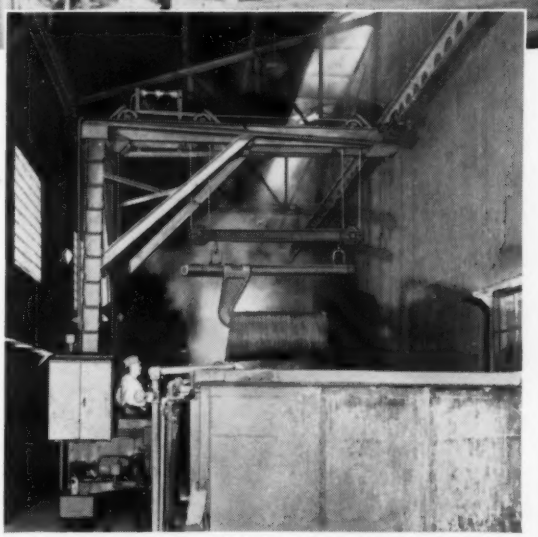


Cleveland Tramrail is easy to install and use. Much of the equipment has been especially designed for wire and rod handling service.



Cleaning house gantry crane. This is one of many Cleveland Tramrail developments that have brought important advantages to the wire and rod industry.

PRODUCERS and fabricators of wire and rod throughout the United States and Canada have long depended upon Cleveland Tramrail overhead materials handling equipment for a wide variety of handling operations.

Cleveland Tramrail is a leader in the development of equipment to especially suit the needs of this industry. For instance: (1) Carriers with special extended propelling arms for block-stripping service as illustrated above; (2) Hairpin-Hook grab for coil handling; (3) Vertical-storage grab for fast selective coil storage; (4) Crane with rotating and tilting hook for horizontal coil storage; (5) Several types of gantry cranes for low-cost efficient cleaning of wire and rod.

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the roller hearth. Cooling is accomplished by inspirating room temperature air through the radiant tubes. The tube assemblies in the first chamber are installed with a bypass for manually controlling the cooling rates, while the others are automatic. The inlet end of the tubes are provided with a special combination premix and diffusion burner, and the outlet end with an eductor, which creates a suction at the outlet end. This feature provides a long flame for even heating of the element and also inspirates the air used for cooling the element when desired. All burners are individually piloted.

The eductor type tubes provide uniform heating through the length of the tube, and also insure that the atmosphere of the furnace is not contaminated by products of combustion. The tubes, because of the internal suction, are always at a lower pressure than the furnace chambers. Therefore, if a leak should occur in a tube after being in service, the only loss would be a certain amount of furnace atmosphere which would be sucked out through the tubes. This feature also allows the furnace to operate until a convenient time is found to replace the tube.

The two types of generated atmosphere gas are supplied from two 5600 cfhr RX endothermic generators and one 10,000-cfhr nitrogen generator. The RX gas is monitored by an automatic signaling dew point controller at each generator and a two point strip chart electron dew point recorder at the furnace. The recorder will record the dew point at the furnace, two samples at a time. However, the sampling lines are manifolded so that all six chambers can be sampled. An automatic, single pen recording controller is used to control the total combustibles in the NX generated gas at the generator.

To provide sufficient circulation of furnace atmosphere through the load, alloy bladed fans are mounted in the roofs of each of the first five chambers. The fans provide ample circulation for mixing the natural gas with the RX generator gas when added carbon potential is required.

Furnace temperature control equipment consists of one, two-position indicating and recording strip chart recording controller; one indicating-recording strip chart controller with a 1400 F contact and four indicating and recording single point strip chart controllers. All instruments are mounted on a single panel in a control room near the furnace. The operator is alerted in case of failure by an alarm system and the equipment is protected by suitable gas shutoff valves and switches.

For running through the continuous furnace the first step is to establish the required conditions of temperatures and atmosphere. The operator rolls the proper number of bars on the charge table rollers and the bars are started through the furnace. The work first passes through an air curtain at the furnace door, then through an 8-ft vestibule containing four sets of heat resisting alloy strip curtains which assist in maintaining the atmosphere. The bars then pass through two chambers used to heat and hold the work at austenitizing temperatures. Depending on the size of the bars and the cycle, the heating can be in any of the first five chambers. After proper austenitizing time, the bars are quickly cooled to transformation temperature as they pass through the cooling zones. The bars then pass through a vestibule at the exit end, similar to the one at the charge end, and to the discharge table. As soon as the load of bars have completely passed on to the table, the operator presses a button and lifting arms between the discharge rollers raise the load, allowing the bars to slide into pockets that parallel the discharge table.

When enough bars have accumulated in the pockets to constitute a "lift" they are removed and returned for further processing such as cold drawing or other cold finishing operation. The bars are descaled by pickling or blasting and lime coated.

This furnace has been in service for several months and has proved very satisfactory. It is necessary that the austenitizing temperature and the transformation temperature be selected to accommodate the particular steel to be run. When these conditions are established the ability to reproduce the results is likewise established. Hardness and structure checks have been made on samples from all positions of a load and prove the uniformity of conditions. ▲

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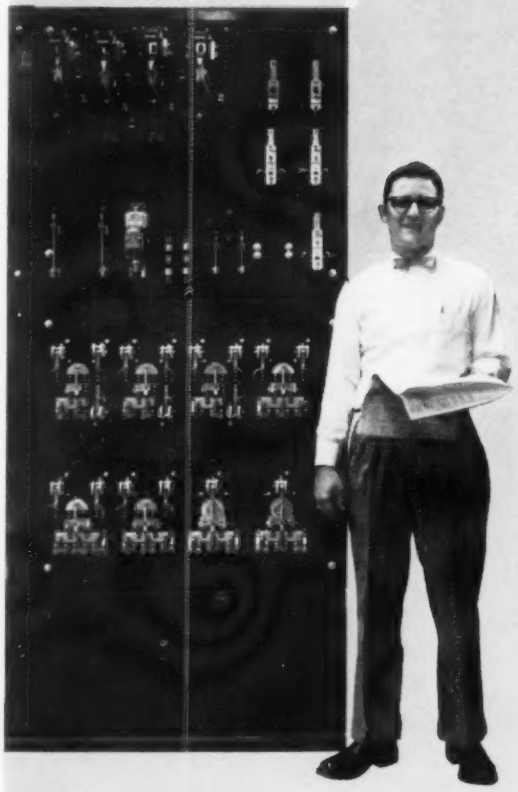

R. M. Bosshardt, Manager,
Heavy Duty Metal Rolling Section,
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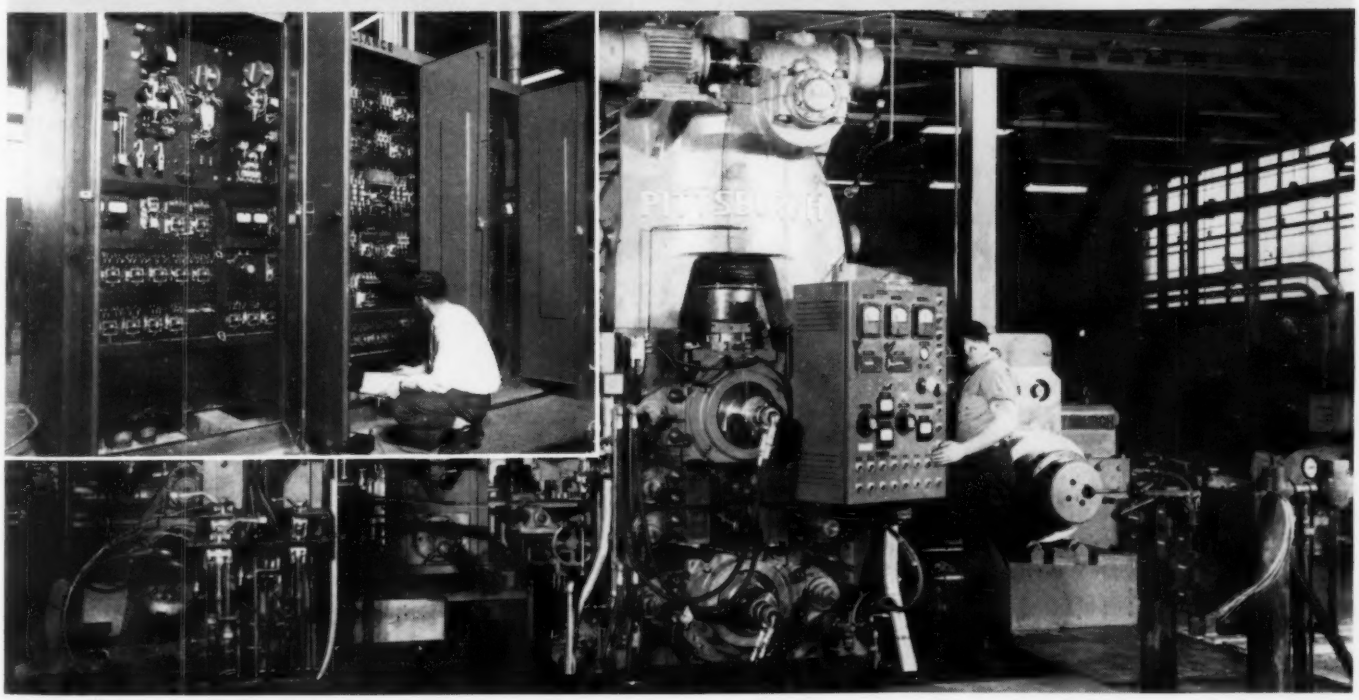
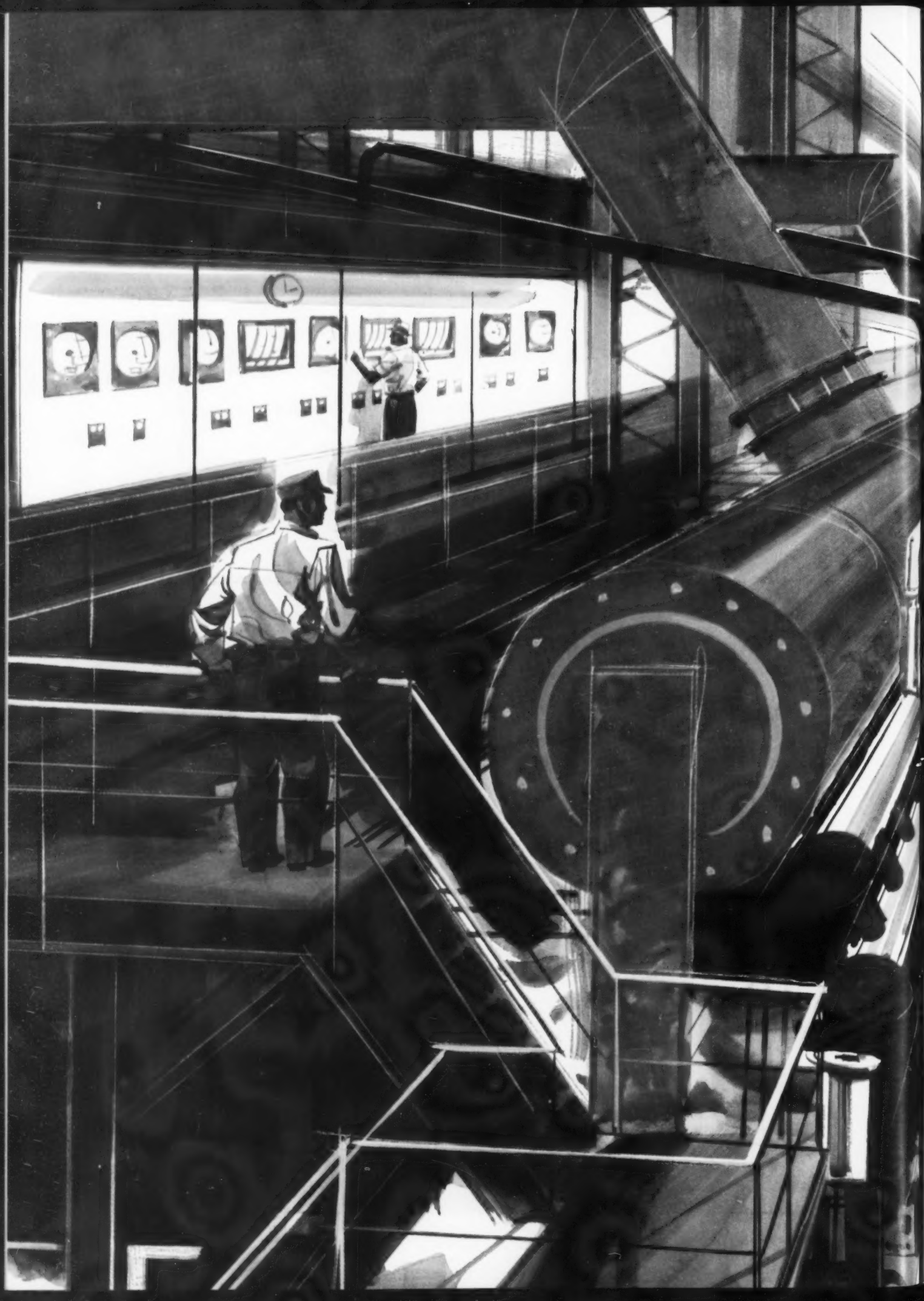
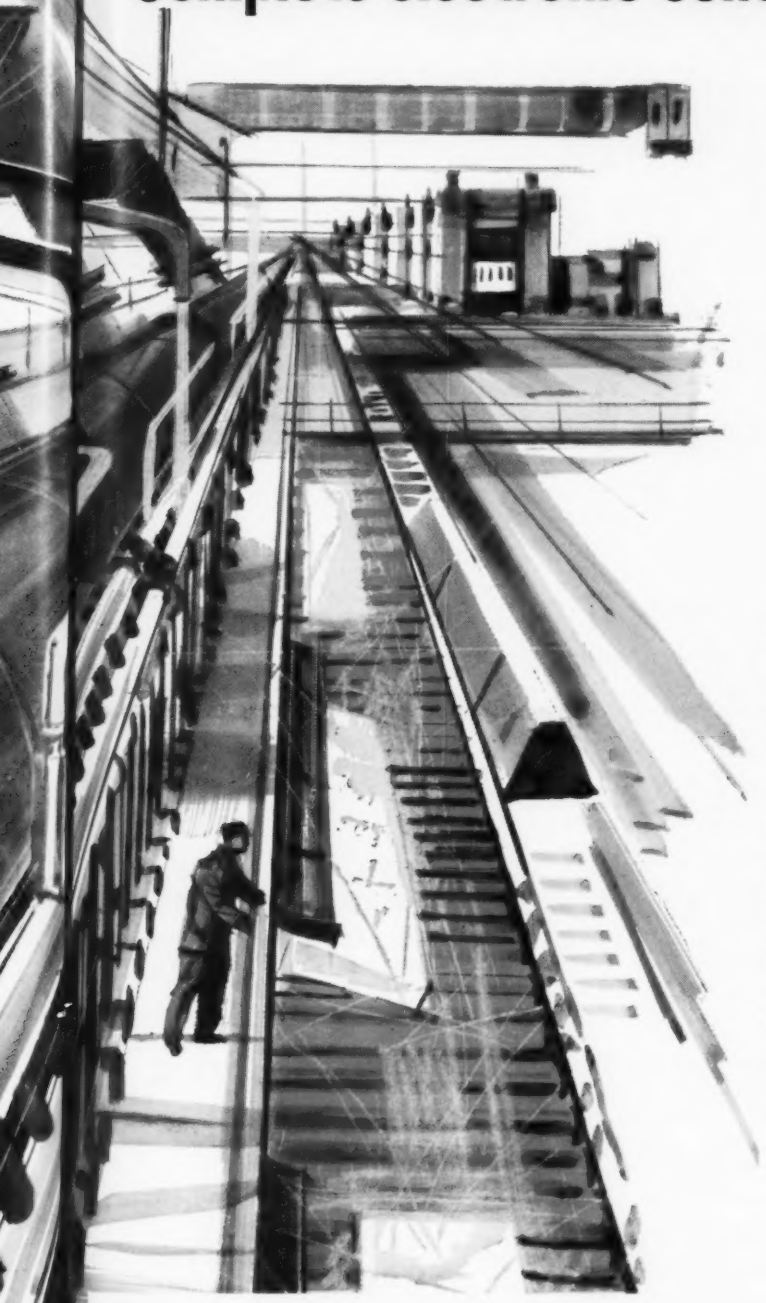




From Republic Flow Meters . . .

Complete electronic control for your reheat furnaces



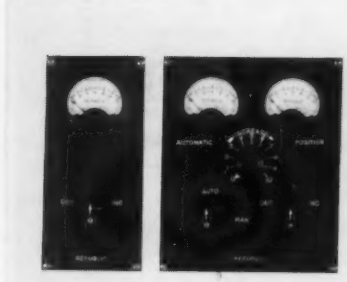
When you install new reheat furnaces, or overhaul your existing ones, check the important advantages you get from Republic Flow Meters complete Control Engineering Service:

1. **Republic furnishes a complete line of instruments and electronic controllers. You get single-source service, single-source responsibility, from preliminary system design to start-up.**
2. **Republic's nation-wide network of experienced field engineers, valuable installation supervision, and final system adjustment and instruction of operating personnel assure you of a properly functioning system.**
3. **Republic's depth of experience in building pneumatic control systems and equipment for over forty years and electronic equipment for the last ten years, assures you the latest in system and product innovation.**

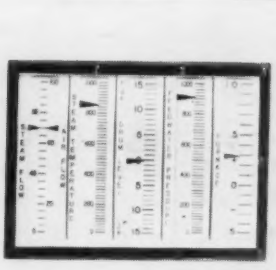
The complete line of Republic pneumatic and electronic equipment handles the recording, indicating and controlling functions for reheat furnace fuel flow and pressure, air flow and furnace pressure. Today, electronic controls for 250 ton furnaces (largest in the world) are being furnished by Republic.

Illustrated on these pages are a few of the many Republic products designed into your reheat furnace control system. Wherever accuracy of response and precise control are important, Republic products and experienced engineering service are available to meet your needs. For information contact the Republic representative nearest you, or write Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Ill. In Canada: Republic Flow Meters Canada, Ltd., Toronto. Subsidiary of Rockwell Manufacturing Company.

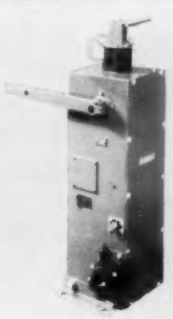
REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL



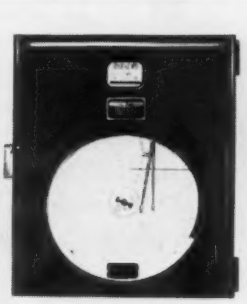
Complete electronic control systems are available for controlling the various functions in an open hearth furnace. Included are transmitters, totalizers, controllers and final drive units.



Republic V-5 Gauges for draft, pressure, flow temperature and differential pressures, have 5" vertical, easy-to-read scales. These small size gauges match performance of larger gauges, require quarter of the space.



Republic Final Drive Units operate valves, damper, inlet vanes, etc., in response to air loading pressures or electronic loading signals. They can be controlled automatically or manually, remotely or locally.



Republic Flow & Pressure Recorders register electrically, pneumatically or mechanically, are simple, compact units of sturdy construction.

Another example of National Roll quality control

Elmer Grinder, left, of National's steel foundry discusses chill location with Bill Williamson of the Sales Department.

Roll molds determine life, not just dimensions

Molding techniques for steel rolls are, of course, directed at obtaining a casting with accurate dimensions for economical machining into precise shaped or plain rolls.

But just as important as dimensions —determined by the "sweep" pattern shown above—is the metallurgical function built into every roll mold. Metal "chills" are carefully located to control cooling of the steel in a manner that will produce a roll both metallurgically and physically sound.

Started on paper, the chill layout is translated into a mold of metal and sand under the watchful attention of National's experienced steel foundry personnel. These men know foundry practice. But perhaps more importantly, they know the demands that are made on roll soundness in the customer's mill.

This is a part of National's service which means better rolls for you. It's one of the many reasons why . . .

National's the growing name in rolls

NATIONAL ROLL & FOUNDRY DIVISION

GENERAL STEEL CASTINGS CORPORATION, Avonmore (Westmoreland County), Pa.

General Steel Castings Corporation, General Offices: Granite City, Illinois • Plants: Granite City, Ill., Eddystone, Pa., Avonmore, Pa.

Date-line Diary...

January 1

Δ The U. S. Dept. of Commerce, Bureau of the Census, reports that shipments of nonferrous castings during 1958 totaled 2,042,000,000 lb compared with 2,350,000,000 lb in 1957; unfilled orders on December 31, 1958, totaled 168,000,000 lb, 7 per cent below the 1957 year end total.

January 4

Δ Assn. of American Railroads estimated 1959 freight loadings at 30,900,000 cars, 2.5 per cent over the 1958 total.

Δ Westinghouse stockholders approved a two-for-one split of the common stock, resulting in an increase of the authorized number of shares from 25,000,000 to 50,000,000, with par value $6.25.

Δ Bureau of the Census reports that shipments of nonferrous castings in October, 1959, totaled 212,000,000 lb, 4 per cent over September, 1959, shipments. Unfilled orders at the end of October totaled 170,000,000 lb, 4 per cent below the backlog at the end of September.

Δ The AISI reports that the operating rate of the steel industry for the week of January 4 is scheduled at 2,707,000 tons (95.0 per cent of capacity, 148,570,970 net tons). This compares with 2,726,000 tons one week ago (96.3 per cent of capacity of 147,633,670 net tons), and 2,085,000 tons one year ago. Index of production for the week is 168.5.

Δ AISI reports that the annual capacity of the steel industry is 148,570,970 net tons for 1960 compared with 147,633,670 net tons in 1959.

January 5

Δ The Bureau of Mines reports that production of Pennsylvania anthracite for December, 1959, was 1,849,000 net tons compared with 1,763,000 net tons in November, 1959 and 1,959,000 net tons in December, 1958. Production for the year 1959 was 19,537,000 tons compared with 21,171,000 tons in 1958.

Δ The joint British government-industry iron and steel board, London, has worked out a $280,000,000 expansion program for 1960, increasing Britain's annual capacity to 25,500,000 tons of ingot steel from 24,500,000 tons.

Δ Steel producers and USW settled their dispute on the basis of a 30-month contract worth about 40¢ an hr when all benefits are in effect.

Δ First National City Bank of New York increased its charges on loans to brokers and dealers, based on securities as collateral, to 5½ per cent, up ½ per cent, similar increases were announced by several other leading New York banks.

Δ Consumer installment purchases in November, 1959, resulted in a $375,000,000 increase, to a total of $38,700,000,000.

Δ The Commerce Dept. estimated that construction outlays in 1959 will increase to $54,300,000,000 compared with $50,000,000,000 in 1958.

Δ USW officially ratified the agreement with the major steel companies.

Δ Government figures showed manufacturers' inventories on November 30, 1959, stood at a seasonally adjusted $51,500,000,000, unchanged from October 31 figures.

January 7

Δ A "memorandum of agreement" signed by the USW and 11 major steel producers disclosed that the companies abandoned all their demands for stiffer penalties against wildcat strikes, greater flexibility in arranging vacations, and freedom to change work schedules without paying overtime penalties. Management proposals for work rules changes goes to a committee for study.

January 8

Δ President Eisenhower reported to Congress that he anticipated a $4,200,000,000 surplus in the 1960-61 fiscal year, expenditures will total $79,800,000,000, revenues about $83,000,000,000.

January 11

Δ The AISI reports that the operating rate of the steel industry for the week of January 11 is scheduled at 2,715,000 tons (95.3 per cent of 1960 capacity). This compares with 2,715,000 tons last week and 2,111,000 tons one year ago. Index of production for the week is 169.0.

January 13

Δ Lead and zinc producers urged the Tariff Commission to recommend greater protection against imports of the two metals. Industry leaders contended mine operators need a "rockbottom price" of 13½¢ a lb for zinc and 15½¢ a lb for lead to reopen mines in Oklahoma-Kansas-Missouri area. Zinc is currently 13¢, East St. Louis; lead 12¢ in New York.

January 14

Δ The AISI reports that steelmaking furnaces produced 93,436,813 net tons of ingots and steel for castings during 1959, compared with 85,254,885 tons in 1958. Index of production in 1959 was 111.6; in 1958, 101.8.

Δ The AISI reported that December, 1959, production totaled 11,980,000 net tons, an all-time monthly record.

January 15

Δ Armco Steel Corp. increased its annual production capacity to 6,800,000 tons from 6,400,000 tons in 1959, replacing Youngstown Sheet and Tube as the sixth largest producer and pushing Inland Steel Co. down in Armco's previous eighth-place position.

Δ Government figures showed that private home starts in December picked up to a seasonally adjusted annual rate of 1,310,000 from the 1,210,000 pace in November; for the year 1959 private starts totaled 1,341,500, compared with 1,141,500 in 1958.

△ The Japan Iron & Steel Federation reports ingot steel production in November, 1959, of 1,739,000 net tons compared with 1,730,000 net tons in October, 1959.

January 18

△ The AISI reports that the operating rate of the steel industry for the week of January 18, is scheduled at 2,712,000 tons (95.2 per cent of capacity). This compares with 2,727,000 tons one week ago (95.7 per cent capacity) and 2,056,000 tons one year ago. Index of production for the week is 168.8.

△ The Bureau of the Census, U. S. Dept. of Commerce, reported shipments of iron and steel castings in October, 1959, totaled 1,052,860 tons compared with 1,025,837 tons in September, 1959, and 1,169,624 tons in October, 1958.

△ Stockholders of Granite City Steel Co. approved a two-for-one stock split, and an increase in the number of shares to 7,500,000 shares from the present 3,000,000.

January 19

△ Business firms were promised a change to depreciate equipment more rapidly. Proposed legislation would apply income taxes rather than capital gains levy to most of the profits made by selling old equipment. For corporations this would mean a maximum rate of 52 per cent.

January 20

△ Weirton Steel Co. signed a new contract with an independent union which provides more liberal benefits than big steel in pact with USW. Pact was made retroactive to July 1, and promised to refund to workers all their contributions made to insurance programs during the last six months. New pact maintains 5¢ hr wage differential over big steel pact.

△ Bureau of the Census reports that shipments of commercial steel forgings in November, 1959, totaled 87,253 tons, compared with 97,302 tons in October, 1959, and 89,011 tons in November, 1958. Unfilled orders as of November 30, 1959, amounted to 402,922 tons, compared with 373,318 tons on October 31, 1959, and 306,508 tons on November 30, 1958.

△ Bureau of the Census reports that net shipments of aluminum pig and ingots for November, 1959, totaled 123,833,000 lb, compared with 126,933,000 lb in October, 1959, and 86,201,000 lb in November, 1958. Net shipments of aluminum mill products in November, 1959, amounted to 247,260,000 lb, compared with 287,081,000 lb in October, 1959, and 216,263,000 lb in November, 1958.

△ The AISC reported that shipments of fabricated structural steel in December, 1959, totaled 235,688 tons compared with 180,772 tons in November, 1959, and 266,600 tons in December, 1958; bookings in December, 1959, amounted to 366,125 tons compared with 260,190 tons in November, 1959, and 196,510 tons in December, 1958. Backlog as of December 31, 1959, totaled 2,194,706 tons. Total bookings in 1959 totaled 3,222,858 tons. Total 1959 shipments were 2,904,409 tons.

△ The Bureau of the Census, Dept. of Commerce, reports that production of titanium mill products for November, 1959, amounted to 474,312 lb, compared with 358,513 lb in October, 1959, and 424,558 lb in November, 1958.

January 21

△ American Zinc Institute, Inc., estimates that U. S. consumption of zinc in 1959 will total about 944,000 tons, compared with 868,327 tons in 1958; estimated European consumption in 1959 is 955,200 tons, compared with 945,000 tons in 1958.

△ Canadian production of steel ingots for November, 1959, totaled 523,219 net tons, compared with 482,878 tons in November, 1958.

January 22

△ The Aluminum Assn. reports that production of primary aluminum in the U. S. in December, 1959, amounted to 162,996 short tons, compared with 153,666 tons in November, 1959, and 152,301 tons in December, 1958. Production for 1959 totaled 1,953,039 tons compared with 1,565,556 tons in 1958.

△ The AISI reports that steel companies have budgeted capital expenditures of $1,600,000,000 for 1960, $640,000,000 above the 1959 outlays for new plant and equipment.

△ The AAR reports that deliveries of new freight cars in December, 1959, totaled 3032 cars, compared with 2191 in November, 1959, and 2621 in December, 1958. Orders in December, 1959, totaled 10,560 compared with 2624 in November, 1959, and 3706 in December, 1958. Backlog on order as of January 1, 1960, amounted to 43,870 compared with 36,555 on December 1, 1959, and 27,596 on January 1, 1959.

△ Resistance Welders Manufacturers' Assn. reports that orders for December, 1959, totaled more than $2,750,000, a gain of 26 per cent over November, 1959. Shipments for 1959 are 29 per cent over 1958 shipments. Backlog on December 31, 1959, amounted to more than $10,000,000.

△ Union Carbide Metals Co., Div. of Union Carbide Corp., announced price reductions of between 1¢ and 3.1¢ per lb on certain manganese alloys including standard ferromanganese, medium-carbon ferromanganese, and siliconmanganese. Price decreases of 1¢ to 2¢ per lb on chromium were announced for two ferrochrome alloys.

January 25

△ Fittsburgh Steel Co. and USW agreed on indefinite extension of the present contract, averting a strike threatened with the expiration of the Taft-Hartley injunction on January 26.

△ The AISI reports that the operating rate of the steel industry for the week of January 25 is scheduled at 2,717,000 tons (95.4 per cent of capacity). This compares with 2,727,000 tons one week ago (95.7 per cent capacity) and 2,178,000 tons one year ago. Index of production for the week is 169.1.

January 26

△ United Engineering and Foundry Co. reports unaudited figures for 1959 show net sales totaled $61,099,158, net profits $6,073,193 or $2.38 per share compared with 1958 total net sales of $90,563,994, net profit $6,909,111 or $2.75 per share.

△ U. S. Dept. of Commerce, Bureau of the Census, reports that shipments of nonferrous castings for November, 1959, totaled 175,721,000 lb, compared with 211,049,000 in October, 1959.

January 28

△ At expiration of the Taft-Hartley injunction, Acme

Steel Co., employees returned to work after a 16-hr walkout; McLouth Steel's three Detroit-area plants were idled by a contract dispute.

△ According to the F. W. Dodge Corp. report, construction in December, 1959, amounted to $2,224,060,000, down 3 per cent from December, 1958. Construction contracts for the year 1959 amounted to a record $36,300,000,000, an increase of 3 per cent over the year 1958 totals.

△ Machine tool builders report that orders for metal-cutting tools in December, 1959, amounted to nearly $46,000,000 compared with nearly $42,000,000 in November, 1959.

△ Westinghouse Electric Corp. reports that for the year 1959 net sales amounted to $1,910,730,000, net income of $85,947,000 or $4.86 per share, compared with 1958 totals of net sales $1,895,699,000, net income $74,772,000 or $4.25 a share.

△ The International Nickel Co., Inc., reported that free world consumption of nickel in 1959 exceeded 400,000,000 lb, compared with 320,000,000 lb consumed in 1958.

△ Report by Phoenix-Rheinrohr, A.G., West European steel and pipe producer, shows sales for fiscal 1958–59 (October 1, 1958–September 30, 1959) of $332,775,120, net profit amounting to $4,952,153, compared with fiscal 1957–58 sales of $359,330,144 and net profit of $4,435,000. Steel production in 1958–59 rose to 2,632,000 net tons from 2,595,000 net tons the year earlier; pig iron production totaled 2,240,000 net tons in 1958–59 compared with 2,226,000 net tons in 1957–58. Export business in 1958–59 declined to $79,425,837 from $91,146,349 in fiscal 1957–58.

January 29

△ U. S. Exports in 1959 totaled $16,300,000,000, which were $10,000,000 below 1958 shipments. Commerce Dept. officials predict 1960 volume will rise $1,500,000,000 to $2,500,000,000 above the 1959 figure.

January 30

△ Pittsburgh Steel Co. signed a new contract with the steelworkers which delays until July a decision on company's demand to cut wage incentive scales.

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Dr. Thomas M. Stout, Process Analysis Department Manager

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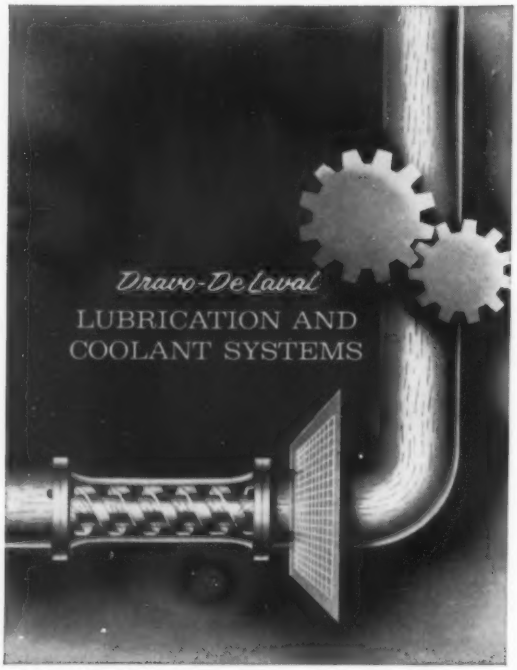

AVAILABLE NOW. New brochure discusses the full line of Dravo-DeLaval Lubrication and Coolant Systems. Address your request for Bulletin No. 1451 to Mill Lubrication, Dravo Building, Pittsburgh 22, Pa.

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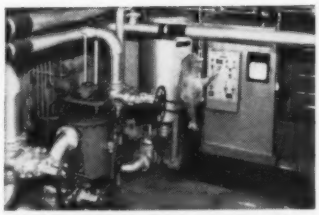
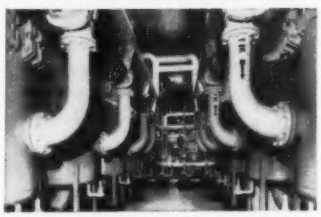
Engineered to meet your precise needs, a Dravo-DeLaval system is designed for economy of operation. Maintenance is easy, and costly machinery is protected by precision lubrication; temperatures and pressures are held at optimum values.



COOLANT SYSTEMS

Custom engineering involves every system component, from oil reservoirs to the full automatic controls. These coolant systems are designed for hot and cold rolling of ferrous and non-ferrous metals, such as aluminum strip and foil.



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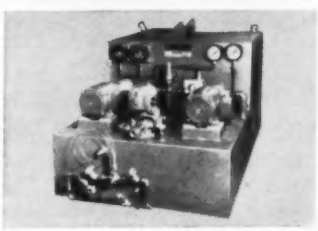
Designed to provide economical, full pressure feed lubrication, the Unilube is a prefabricated "package" which offers all the advantages of the larger custom designs. Capacities range from 1 gpm to 75 gpm over the full range of viscosities.



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Industry News...

U. S. STEEL CORP.'S YOUNGSTOWN DISTRICT WORKS WILL ADD NEW CONDITIONING FACILITIES

△ U. S. Steel Corp.'s Youngstown District Works will add facilities to widen product range, and increase production of high-quality open hearth alloy steel.

Production of open hearth alloy steels for strip, T-1 grade sheets and bars will be increased by 11,000 tons. Production of other high quality steels such as Cor-Ten and Tri-Ten also will be increased.

In order to manufacture these new types of steel, additional facilities will be installed at the primary and secondary rolling mills.

Three new warming furnaces will be constructed at the Ohio Works primary mills; one 150-ton car bottom furnace at the 40-in. mill; and two 70-ton car type furnaces at the 43-in. mill. With these new furnaces in operation, it will be possible for steelmakers to better control temperature before and after the rolling operation, which is of prime importance in the making of these specialized steel products. Also additional quality control facilities will be placed in the open hearth department which will permit metallurgists to make speedy tests by the use of a spectrograph during the steelmaking process.

Other major improvements include a new soaking pit at the 40-in. mill, and new slow cooling facilities at No. 14 mill at McDonald.

REPUBLIC COKE CONVEYOR NEARS COMPLETION

The 239-ft center span of Republic Steel Corp.'s new coke conveyor at Cleveland, Ohio, is hoisted into position. Designed and constructed by McDowell Co., Inc., the facility will replace previous train hopper-car haulage methods. Currently coke is transported by hopper car from the steel company's coke plant on the east side of the Cuyahoga River to four blast furnaces on the west. Completion of the project is expected by late spring. When in operation, the conveyor's 48-in. belt, which has three flights totaling 2593 ft, will have a capacity of 300 tons of coke an hour, traveling at 240 fpm.

J&L TO ADD NEW INGOT HANDLING FACILITIES

△ A new system, designed to facilitate the handling of steel ingots, is being installed at the Aliquippa Works of Jones & Laughlin Steel Corp.

The system, which is expected to cost more than $300,000, will include, a new open runway for the stocking, shipping and handling of ingots, a 15-ton overhead electric crane, a new system of both standard and narrow gage railroad tracks, mold conditioning facilities and an intercom system. The crane runway will be 250 ft long and 128 ft wide and will have approximately 32,000 sq ft of space served by the crane.

It is being installed to facilitate the movement of ingots from the ingot stripping yards to the soaking pits or to storage areas.

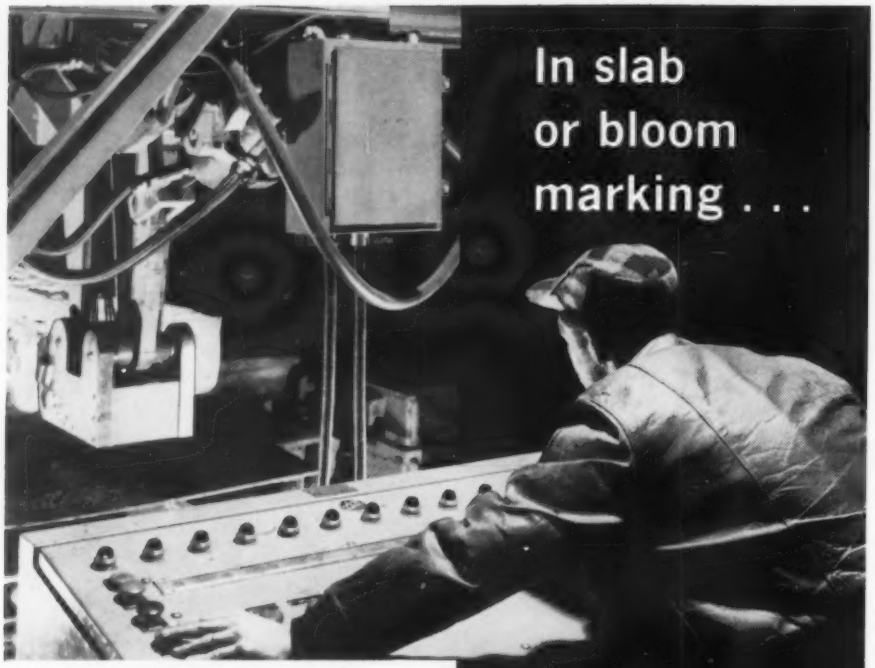
The new facilities are designed to eliminate a sometimes serious bottleneck to open hearth and blooming mill production.

In the flow of materials at the Aliquippa Works, ingots are poured in the Open Hearth and Bessemer, or the Basic Oxygen Department, stripped of ingot molds in the ingot stripping yard, and then moved to one of several possible destinations. A large majority are placed in soaking pits for rolling on the blooming mill while others are placed in storage for later rolling, or shipped for additional processing at J&L's Pittsburgh Works.

ORE BRIDGE TO FEATURE BUCK-BOOST SYSTEM

△ The first buck-boost electrical system to power an ore bridge will be installed in 1960 at U. S. Steel Corp.'s Gary Steel works.

Developed jointly by General Electric and the American Bridge Division of U. S. Steel, the new design will provide an effective,



Operator presses button to actuate stamping cycle or change characters—installed at a transfer table.

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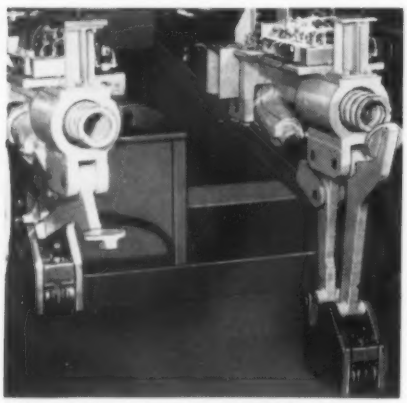
HAS THE
EXPERIENCE



Twin units for automatic consecutive numbering of 2½" bar billets—for installation along edge of cooling bed.

13 UNITS IN SERVICE
. . . 2 ON ORDER

Double-headed Slab Marker with 18 stamping wheels, photographed during testing—for installation over a roller line.

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economical means of utilizing the existing 250-volt d-c constant potential power system to obtain adjustable-voltage drives.

Basic principles of the buck-boost drive have been used previously on other steel industry applications, but never on an ore bridge. The idea for this application was conceived by American Bridge engineers.

Scheduled to begin operation next fall, the new ore bridge will have a bucket capacity of 22½ tons and a free-digging capacity of 1750 tons per hour, based on an average lift of 40 ft and an average trolley distance of 135 ft.

In designing the buck-boost adjustable-voltage system, General Electric engineers were able to use a 500-hp motor-generator set drive motor and three 200-kw generators. The generators are electrically and mechanically interchangeable. In order to provide the same free-digging capacity and same percentage of margin, a conventional adjustable-voltage system would have required doubling the ratings of each unit of the m-g set.

Motors driving the individual motions receive half of their full-speed voltage from the line and the other half from the generators. Use of this technique cuts ratings of the m-g set by 50 per cent, engineers said.

Engineers pointed out that the controlled acceleration offered by adjustable-voltage drives will provide faster trolley operation and reduce cable and gear shock. Other advantages include lower maintenance costs, reduced power consumption and lower demand peaks.

Besides the motors and m-g set, General Electric also is furnishing the controls and switchgear for the new bridge.

TWO EATON SUBSIDIARIES HAVE BECOME DIVISIONS

△ In a move toward further corporate integration, Eaton Manufacturing Co. announced that its wholly owned subsidiary, the Cleveland Worm & Gear Co., and the latter's subsidiary, the Farval Corp., have become divisions of Eaton under the present respective names.

At the same time, George H. Acker, president of Cleveland Worm & Gear and Farval, has been ap-

STEEL MILL CUTS REGRINDING TIME IN HALF WITH MIDVAC

Micro Lustre

VACUUM MELTED FINISHING ROLLS

A switch from air-melted rolls to MidVac Rolls reduced regrinding and refinishing time by as much as 50% in one large steel mill. Now, operators can refinish rolls quicker to a higher polish which produces finer sheets.

MidVac Rolls are made with consumable electrode vacuum melted MidVac Steels. These super-alloy steels produce a Micro-Lustre finish made possible by super uniformity of fine grain structure, maximum freedom of defects and non-metallic inclusions. MidVac Micro-Lustre Rolls assure rolling free from surface imperfections . . . quicker regrinding . . . and give longer trouble-free service between grinds.

MidVac Rolls are being used throughout the nation for rolling stainless steel, aluminum, foil, brass and precious metals. Midvale-Heppenstall also make forged rolls of any size, for any purpose required in the rolling of steel, aluminum, copper, brass and other metals . . . as well as paper, plastics and rubber. Write for complete data on these new Micro-Lustre Rolls.

MH

MidVac Rolls

MIDVALE-HEPPENSTALL CO., NICETOWN, PHILADELPHIA 40, PA.

Subsidiary of HEPPENSTALL COMPANY, Pittsburgh, Pa.

PLANTS: Pittsburgh, Pa. • Bridgeport, Conn.
New Brighton, Pa.

Largest Merchant Iron Producer in U. S. Chooses

WHIRLEX ID FANS

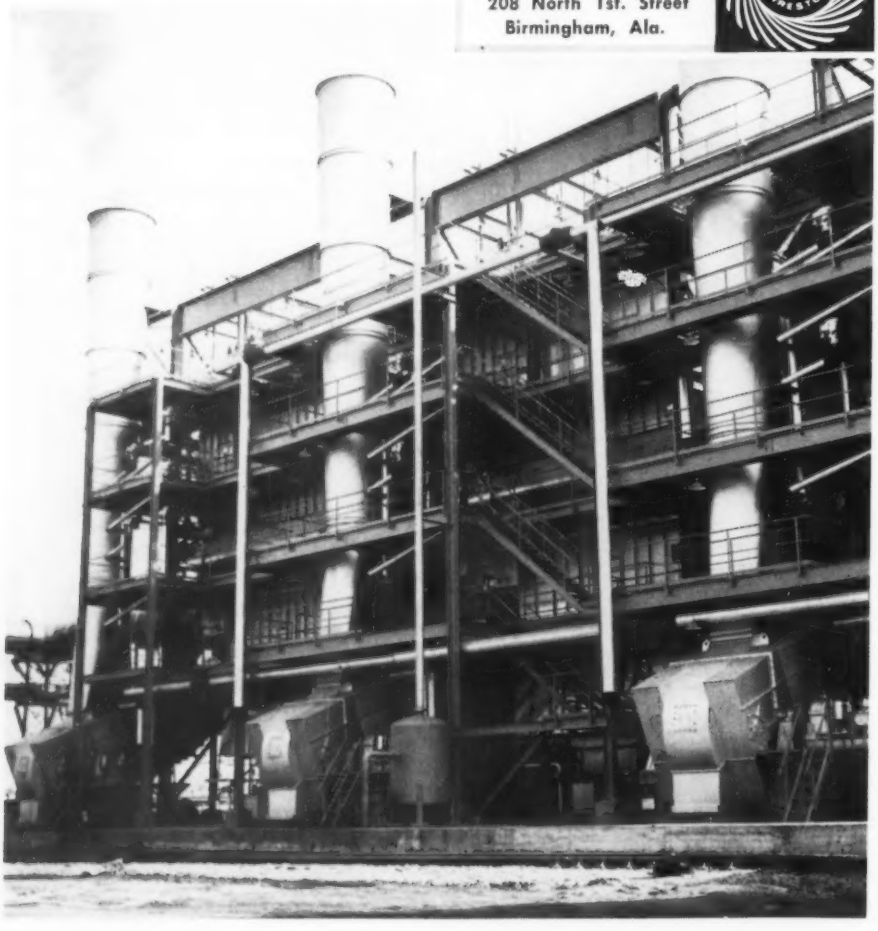
High Erosion Resistant Fan Wheel Assures Longer Life . . . Minimum Maintenance

The largest furnace in the country producing merchant pig iron was recently placed in service as part of an expansion program by a major Southern mill. The new furnace has a rated capacity of 1000 tons per day and is one of the most modern in the country with respect to mechanization and automatic controls.

Because of their unique design and high erosive resistance, WHIRLEX heavy duty induced draft fans were chosen to handle the hot blast furnace gas. The three units shown here carry approximately 150,000 cubic feet of gas per minute. Preliminary fan examinations show wear to be less than a third that of ordinary fans designed for this purpose.

A Whirlex fan installation may solve your problem. Write or wire us.

Fly Ash Arrestor Corp.
208 North 1st. Street
Birmingham, Ala.



pointed general manager of the two divisions with full administrative responsibilities.

Cleveland Worm & Gear and Farval were acquired by Eaton on January 31, 1959, and since then have been operated as subsidiaries.

FIRM TO MARKET GERMAN FORGING MANIPULATOR

△ Salem-Brosius, Inc., will market in the United States and Canada the Hydraulik forging manipulator, designed and built by Hydraulik GmbH, Duisburg, Germany. While the basic machine will be built in Germany, to American standards, Salem-Brosius will supply such components as electrical equipment and handle the assembly, installation and service.

Designed for heavy, rugged operating conditions of hammer or press forging, the Hydraulik machine operates on a closed water-hydraulic system. The 1420-psi hydraulic pressure in the system is derived from machine-mounted accumulators charged with compressed air. Electric motor-driven pumps continuously maintain the hydraulic level in the accumulators. Emulsified oil in the hydraulic system lubricates pumps and other moving parts.

The capacities of these machines are determined by the maximum weight of hot stock they will manipulate during forging. Capacities range from 3 to 110 tons, and seven different models make up the line. The present Salem-Brosius auto-floor type machines range in load carrying capacities from 1 to 10 tons.

CONSTRUCTION OF NEW OXYGEN PLANT UNDERWAY

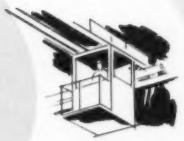
△ Construction of an oxygen generating plant with a 400 ton per day capacity has started at Mingo Junction, Ohio. A joint venture of Hydrocarbon Research, Inc. and Wheeling Steel Corp., the Mingo Oxygen Co. is erecting the $6,000,000 plant to sell oxygen to Wheeling Steel and liquid oxygen and argon for industrial distribution.

The plant, located on property leased from Wheeling Steel, will use HRI's air separation process

(*Please turn to page 173*)

Warmth for isolated workers

IN PULPITS...



CRANE CABS...

ORE BRIDGES... ELSEWHERE

THE
LINTERN
Circulates... Ventilates **HEATER**

The Lintern Heater takes less space and yet provides more effective heat distribution than any heater previously offered for crane cabs, watchmen's shanties and similar confined areas. An optional filter is available where dirt is a problem. Installs on ceiling, wall or floor. Low in cost, compact in size, light in weight, highly dependable. Available in all AC or DC voltages.

Write for full information

Larco, inc.

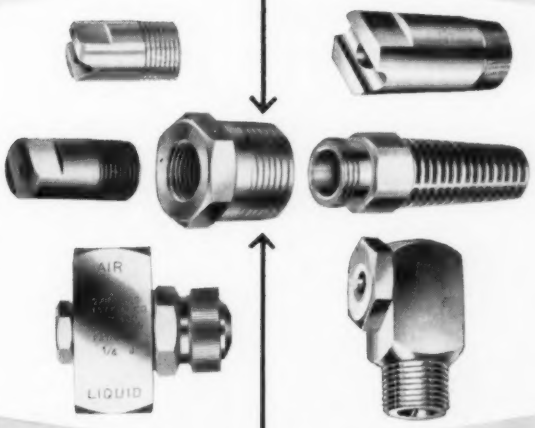
Distributor of Lintern Corporation Products
Route 20 East, Painesville, Ohio

proved
SPRAY NOZZLE *design*

TO IMPROVE SUCH SPRAYING OPERATIONS AS

• DESCALING • HOT STRIP COOLING • ROLL COOLING • COOLING SLABS—INGOT MOLDS — OPEN HEARTH TUNNELS — PIGS • COKE CHEMICAL PROCESSING • LUBRICANT SPRAYING • AIR AND GAS WASHING

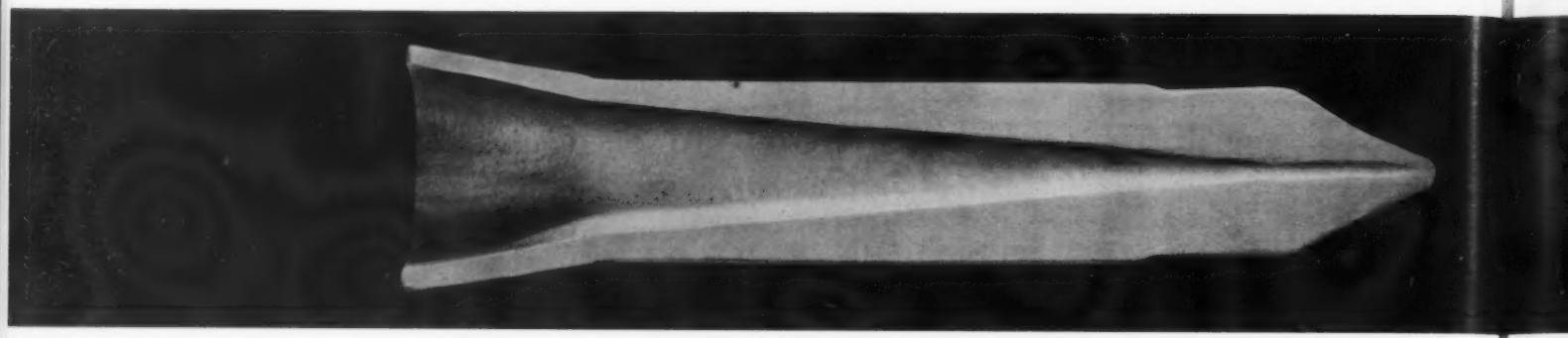
Whatever the application you will find Spraying Systems Spray Nozzles provide noticeable improvement in spraying operations . . . and often materially lower cost. Proved by performance. Supplied in a complete choice of types and capacities for selection of spray characteristics exactly as needed. Your inquiry is cordially invited.



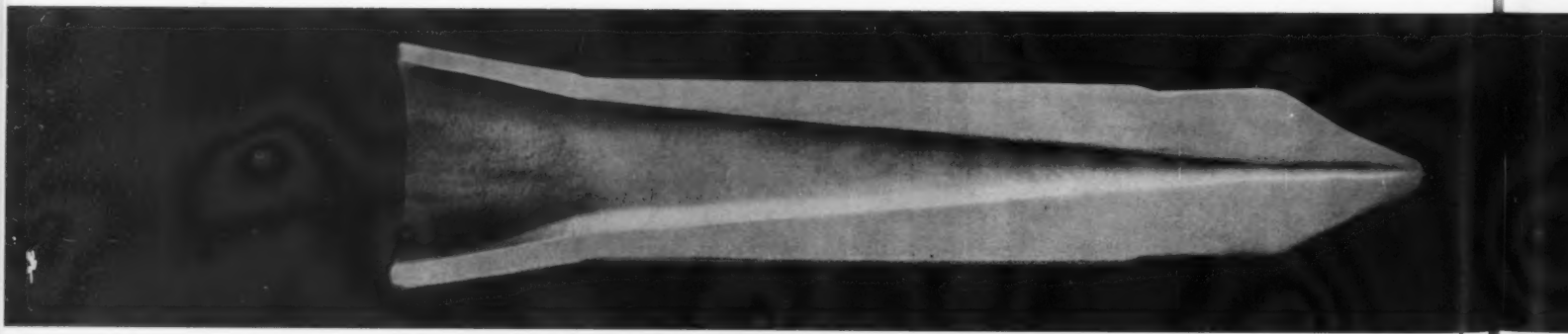
SPRAYING SYSTEMS CO.
3262 Randolph Street • Bellwood, Illinois

For complete information write for Catalog 24 and special data sheet folder "Steel Mill Applications".

NBD T-3
23 STD



NBD T-3
23 STD



NBD T-3
23 STD

NBD T-3 ALLOY GUIDES LAST LONGER

Here's an actual case history:

Cast-iron guides	3 days
No. 1 alloy guides	4 days
No. 2 alloy guides	6 days
NBD T-3 ALLOY GUIDES	21 days

NBD T-3 ALLOY GUIDES PREVENT COBBLES

T-3 is self polishing. Guides made of the alloy do not pick up steel. The big advantage — cobbles, a common and costly problem of high-speed rod rolling, are eliminated.

NBD T-3 ALLOY GUIDES REDUCE REJECTS

Another major benefit of the self-polishing properties of T-3. Resistance to scale build-up means far fewer guide scratches...far fewer rejects at final rod inspection.

NBD T-3 ALLOY MAY BE WELDED AND MACHINED

Worn guides may be rebuilt with T-3 Alloy rod. The built-up parts are readily machined and have the same excellent wear-resistance and self-polishing properties as the parent T-3 alloy.

AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION

717-G Grant Building • Pittsburgh 19, Pennsylvania

How to get greater yield at your present production rate

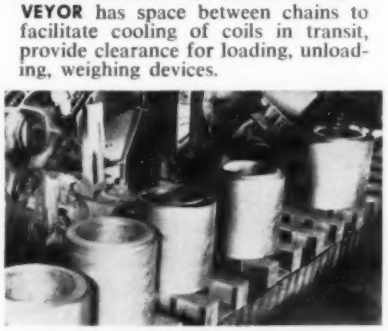
V-TOP PALLET CONVEYOR transports huge coils from coiler to storage in this hot strip mill. Link-Belt's two other basic coil conveyor types are shown below.

LINK-BELT coil conveyors increase output by reducing delays and scrap losses

With Link-Belt coil conveyors, movement of coils is controlled . . . there's no telescoping . . . no scuffing of edges. These rugged but gentle conveyors move coils up to 75,000 lbs. They travel smoothly around corners, up and down inclines . . . and they promote safety by eliminating the need for vehicles and limiting the use of overhead cranes.

Link-Belt also offers auxiliary devices that transfer coils from one conveyor to another . . . turn, lower, tilt or weigh them with ease and precision. For full details, call your nearest Link-Belt office.

DOUBLE-STRAND ROLLER CHAIN CONVEYOR has space between chains to facilitate cooling of coils in transit, provide clearance for loading, unloading, weighing devices.



CAR-TYPE CONVEYOR consists of a series of heavy cars—each car accommodates one coil which is carried on end and supported by a pair of cross beams. Air circulates around coils.

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,956

(*Continued from page 168*)

to produce oxygen of 99.5 per cent purity for Wheeling to use in their steelmaking processes, scarfing and for general plant purposes. Wheeling's oxygen will be piped to adjacent Wheeling plants in Mingo Junction and three miles distant to Steubenville.

The new plant, which is scheduled to be in operation by late 1960, can be expanded to at least 600 tons per day capacity. Hydrocarbon Research Inc., which designed and engineered the plant, will handle the construction and, later, will supervise operations.

COMPANY ANNOUNCES EXPANDED OPERATIONS

△ The R. T. Patterson Co., Inc. has recently opened offices at 350 Grant Building, Pittsburgh, Pa., and announces a greatly expanded operation in the field of consultation, engineering, management and construction of industrial, utility and steel enterprises.

Principal of the firm, R. T. Patterson, formerly was president of Patterson-Emerson-Comstock, Inc.

AWARDS CONTRACT FOR VACUUM MELTING UNIT

△ A $1,000,000 contract covering the design and construction of the world's largest vacuum melting furnace has been placed by Midvale-Heppenstall Co.

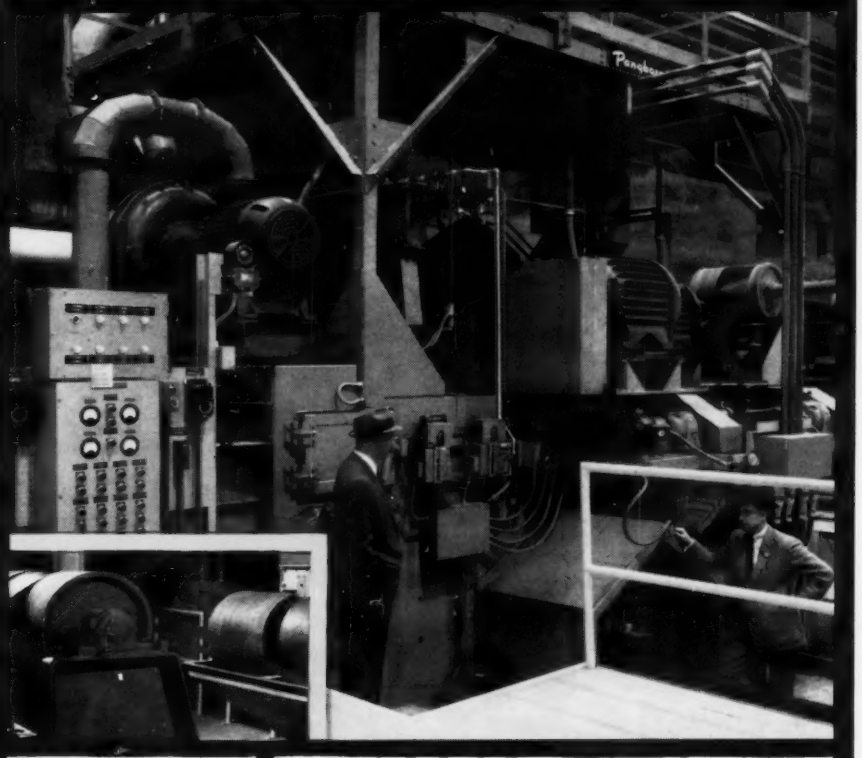
The furnace will be designed to melt, by the consumable vacuum-arc method, electrodes of alloys and steels of varying compositions. The resulting ingots will be 40 in. in diam and weigh 25 tons.

Heraeus GmbH of Hanau, Germany will design the unit and supply some of the vacuum and electronic control equipment. Consolidated Vacuum Corp. will be responsible for the construction and installation. The majority of the components will be produced in this country.

The projected annual capacity of the furnace is 8000 tons. A portion of the output will be sold in the form of semi-finished slabs and billets to rolling mills and to manufacturers of closed die forgings.

Most of the output, however, is expected to be used in the company's own plant and in the plants of its

PUSH-BUTTON DESCALING WITH ROTOBLAST!



Universal Cyclops uses Pangborn Rotoblast Descaling for flexibility in automation

Devoted entirely to the production of cold rolled stainless steel strip, the new Coshocton, Ohio, plant of Universal Cyclops Steel Co. is one of the most completely modern plants in the country.

Among its advanced equipment, the company uses a Pangborn Rotoblast Descaling Machine in a 659 ft. fully-automated line. This machine—requiring no operator—continuously blast cleans two strands of steel simultaneously at speeds up to 80 LFM. To provide a high degree of flexibility, it has individual strand control and permits changing the position of Rotoblast wheels at the touch of a button. Abrasive velocity and volume are also variable and two-speed motors give a choice of 50 h.p. at 1200 RPMs or 75 h.p. at 1800 RPMs, depending on type and thickness of work.

Rotoblast's efficiency and adaptability to individual descaling problems have proved the value of Rotoblast to Universal Cyclops. They can in *your* plant. For more information, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment—Rotoblast Steel Shot and Grit.*

Pangborn

Cleans it fast with ROTOBLAST®

parent company, Heppenstall Co., in Pittsburgh, Pa., and in Bridgeport, Conn. In this instance, ingots will be converted to heavy forgings by the open die process on flat die presses and hammers. Rough and finished machined forgings will be manufactured for the company's regular customers who produce equipment in which highly stressed parts require maximum metal cleanliness.

While the new furnace will produce ingots up to 40 in. in diam, it is being designed to permit research and experimentation in the casting of ingots up to 60 in. in diam.

EXPANSION PROGRAM IS SET FOR OHIO SEAMLESS

△ An extensive program to expand manufacturing facilities at the Ohio Seamless Tube Division of Copperweld Steel Co., Shelby, Ohio, has been announced by R. M. Pittenger, vice president in charge of the division. During 1960, approximately $3,000,000 will be expended for new equipment and to revamp present facilities.

Of the funds allocated $2,100,000 will be employed to expand electric-weld tube production. Two new welding mills will be purchased and two of the plant's present mills will be rebuilt. Annual welded capacity will be increased by 50,000 net tons. The electric-weld size range will be increased from its present limit of 3-in. OD to 7 in., equal to that of the division's seamless tube size range.

Balance of the funds will be applied for new equipment and improvements throughout the Ohio Seamless Tube plant, from hot mill to finishing department.

MORGAN ENGINEERING TO EXPAND AND MODERNIZE

△ The Morgan Engineering Co. will embark on a major $1,800,000 expansion and modernization program for 1960.

Work will begin immediately on the construction of 72,000 sq ft of covered plant area; 55,200 sq ft of new yard storage area; and, the redesign and remodeling of 19,000 sq ft of existing plant installations.

The new expansion and modernization will provide Morgan with significant increases in manufacturing capacity; and the improvement of the movement of work through the plant, as well as more efficient storage of inventory supplies. Almost all of the company's vast operations will be effected by either new construction or rearrangement of existing facilities.

A master plan for modernization of Morgan's entire manufacturing operation was begun five years ago and involved thorough plant evaluation and preliminary engineering studies and included the purchase and installation of nearly $3,000,000 in new machine tools and equipment.

Meeting

△ The 10th Annual Iron & Steel Conference co-sponsored by the Metals and Ceramics Industry Division and the Pittsburgh Section of the Instrument Society of America, will be held at the Pick-Roosevelt Hotel, Pittsburgh, Pa., March 23 and 24.

SUPERIOR
CARBON
BRICK
FOR
Blast furnace linings
Blast furnace run-out troughs
Cupola linings
Steel pickling tanks
Standard sizes and shapes • Tested performances
Competent technical service • Superior chemical and metallurgical characteristics • Graphite brick also available.
May we give you a quotation?
ELECTRODE GLC DIVISION
GREAT LAKES CARBON CORPORATION
18 EAST 48TH STREET, NEW YORK 17, N.Y. • OFFICES IN PRINCIPAL CITIES

SOLID!
Section of Roebel bar for 22,000 Volt, 76,000 KVA turbogenerator stator.

The outstanding insulation for high voltage coils

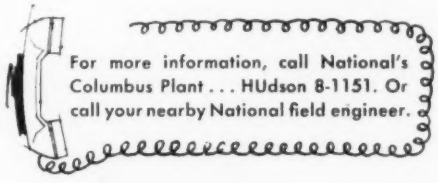
NECCOBOND...solid insulation bonded to the copper provides longer life, greater strength and stability

In NECCOBOND, National has developed a complete insulation system, using mica, glass and a special impregnant. Its particular advantages for high voltage coils are:

- Exceptional thermal stability.
- Optimum mechanical and electrical properties.
- High heat conductivity.

NECCOBOND is based on time-proven insulating materials – mica and glass. These are welded by a special impregnant into a tenaciously bonded, resilient, voidless insulation wall. A unique method of fabrication assures homogeneous insulation.

When replacing high voltage coils, investigate the long term savings with NECCOBOND. You'll find our advice impartial—we offer all types of insulation.



McGRAW EDISON

National Electric Coil

DIVISION OF McGRAW-EDISON COMPANY
COLUMBUS 16, OHIO

ELECTRICAL ENGINEERS • MANUFACTURERS OF ELECTRICAL COILS, INSULATION, LIFTING MAGNETS
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

Yoder Rotary Slitters reduce inventory... speed production

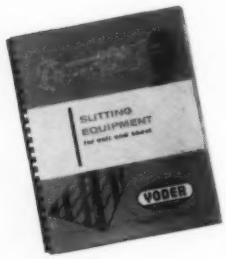
To help meet the demands of tight production schedules, YODER Slitters reduce mill-width stock quickly and economically to desired widths. If your needs are as low as 100 tons per month, time and manpower savings alone will offset the cost of your YODER Slitter in a matter of months, while reducing basic inventories. Compactly designed, standard YODER Slitters are built to handle standard coil widths...completely engineered lines for special requirements.

YODER accessories, such as coil cars, swivel unloaders, scrap choppers, scrap disposers, plate levelers and coil boxes, make stock handling fast and easy.

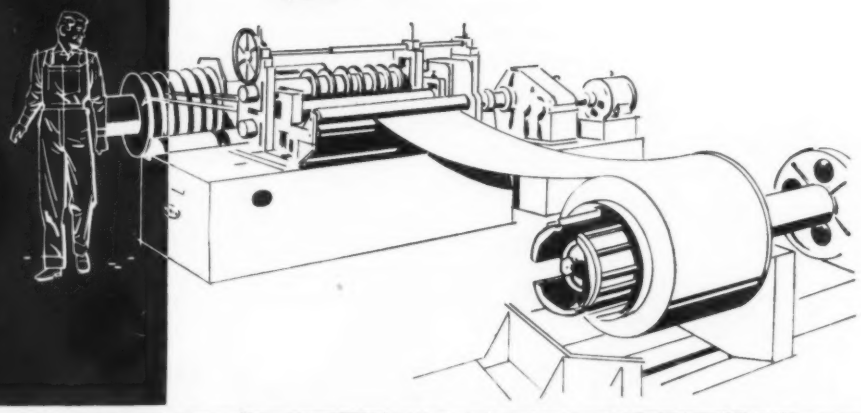
YODER also makes a complete line of Cold Roll-Forming equipment and Pipe and Tube Mills. To profit from YODER'S years of engineering and service experience, contact your local YODER representative or send for the YODER Slitter Manual.

THE YODER COMPANY

5495 Walworth Avenue • • Cleveland 1, Ohio



Investigate the many advantages of YODER-engineered Slitter Installations. Write today for this comprehensive, 80 page YODER Slitter Manual ... it's yours for the asking!



ENGINEERING **YODER** MANUFACTURING

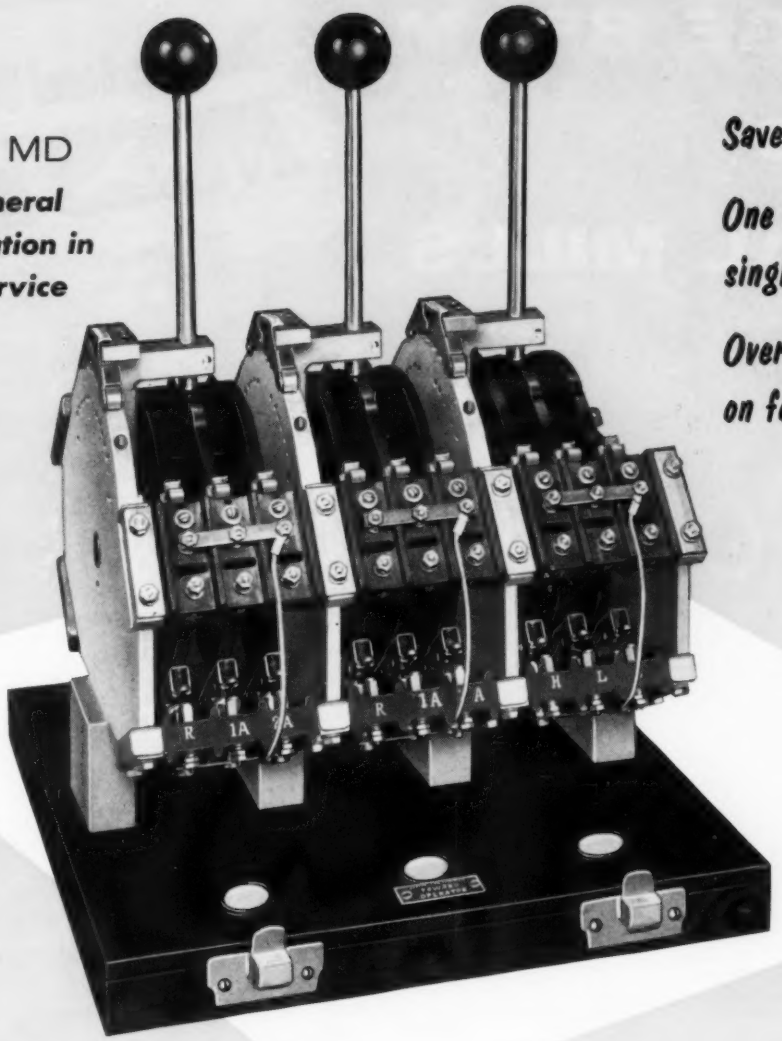
ROTARY SLITTING LINES

PIPE AND TUBE MILLS (ferrous or non-ferrous)

COLD ROLL FORMING MACHINES

Type MD

for general application in Mill Service



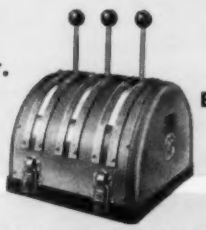
Save valuable mounting space

One to four switches in a single enclosure

Overall length less than 22" on four unit switch

P-G master switches

Unique in design, the Post-Glover Type MD Master Switch saves valuable mounting space in crowded crane cabs or mill pulpits where sufficient room has always been a problem. Each single Master has a maximum of 12 circuits and up to 6 points either direction. The operating lever has exceptionally short angular travel and can easily be adjusted in length, thus adding to operator comfort and efficiency.



Enclosure easily removed.

Write for Bulletin 410

THE **POST-GLOVER** ELECTRIC COMPANY

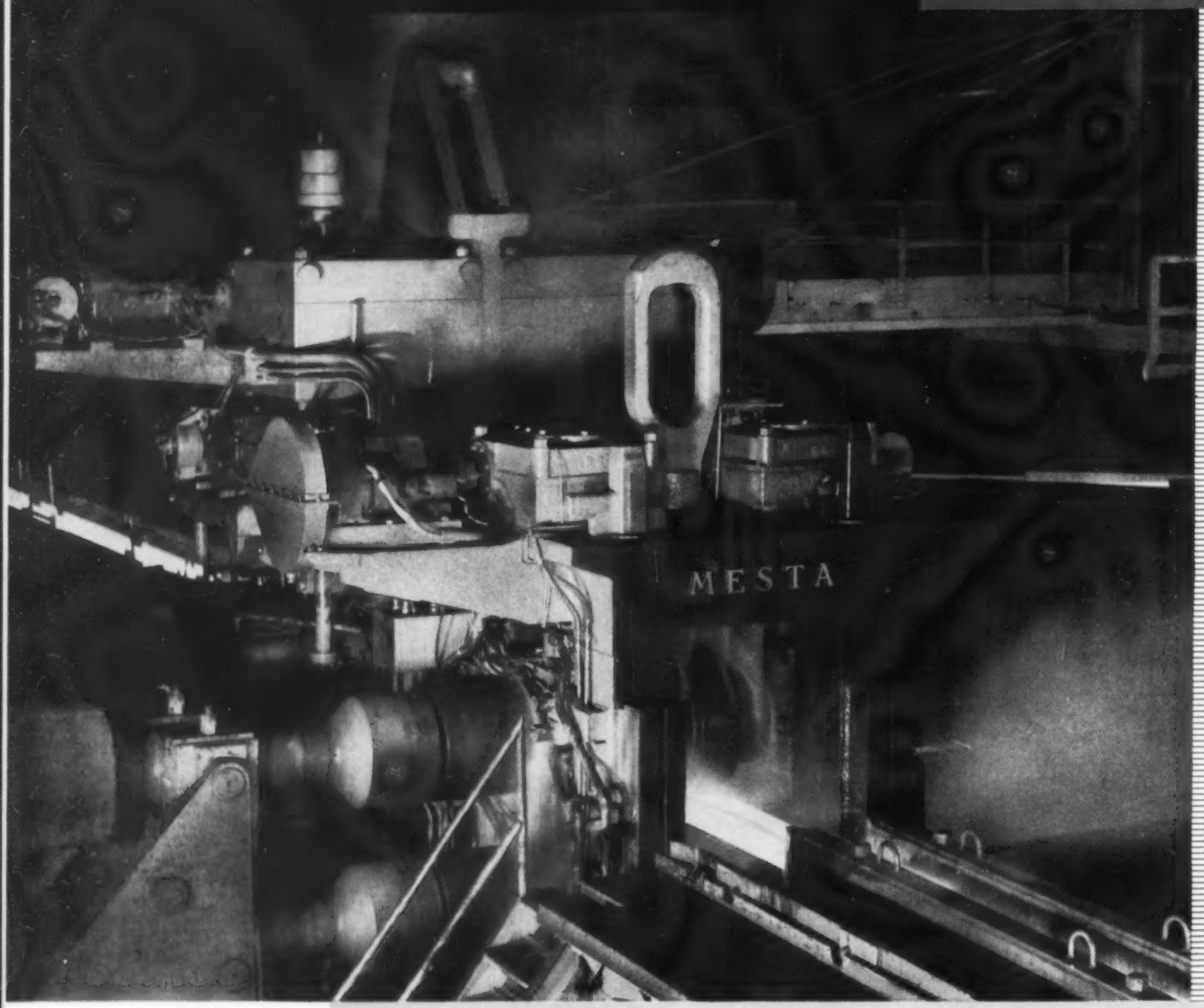
Established 1892

Office and Factory—KENTON LANDS ROAD, ERLANGER, KENTUCKY

Mailing Address—BOX 709, COVINGTON, KENTUCKY

WIDE FLANGE BEAM AND STRUCTURAL MILLS

Designed and Built by MESTA



MESTA Universal Structural Mill rolling wide flange beams on the 44" Universal Stand and the 34" Edging Stand at Inland Steel Company, Indiana Harbor Works

Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

MESTA
THERE IS NONE BETTER

Personnel News...

Thomas W. Hunter was appointed general manager, operations—steel of United States Steel Corp. Succeeding Mr. Hunter as general superintendent of Gary Works is **Frederick A. Dudderar,** formerly general superintendent of Clairton Works. **John M. Walsh, Jr.,** succeeds Mr. Dudderar at Clairton.

Mr. Hunter joined U. S. Steel in 1936 as assistant to the tin house superintendent of the former Shenango Works. The following year he was transferred to Irvin Works as assistant to the superintendent of the Tin Finishing Department, subsequently becoming superintendent of flat products at the plant in 1941. He was transferred to Gary Sheet and Tin Mill, Gary, Ind., in 1944, and was tin mill division superintendent at the time of his return to Irvin Works as assistant general superintendent in 1950. He was made general superintendent of that plant in 1955 and assistant to vice president—operations in 1957. Following the latter promotion he moved to Gary Steel Works as general superintendent.

Mr. Dudderar joined U. S. Steel at Clairton Works as a practice apprentice in the industrial engineering department in 1940. In 1941, he was transferred to the Pittsburgh general offices of industrial engineering. The following year he moved to Homestead District Works, advancing to assistant to the plant industrial engineer. Mr. Dudderar returned to Clairton in 1944 as assistant plant industrial engineer and that same year became assistant to the division superintendent, coke and coal chemicals. In 1951, he was appointed division superintendent, and in 1955, was named assistant general superintendent at Clairton. He was advanced to general superintendent at the plant in 1958. Mr. Walsh joined U. S. Steel in 1931 as assistant special engineer of the Carrie Furnaces at Homestead District Works in Rankin, Pa., and was transferred to Edgar Thomson Works in 1936 as assistant to the superintendent of blast furnaces. In 1939, he was promoted to general blast furnace foreman. In 1941, he moved to Clairton as assistant blast furnace superintendent, and became superintendent in 1945. He returned to Edgar Thomson in 1948 as superintendent of blast furnaces, and was transferred to Gary as division superintendent of blast furnaces in 1950. In 1954, he was promoted to assistant to general superintendent at Gary and two years later was appointed assistant general superintendent.

A. P. Miller has been elected president of Acme-Newport Steel Co., subsidiary of Acme Steel Co. Mr. Miller moves up from his post as vice president and general manager of Acme-Newport. He entered the steel industry in 1916 in the Metallurgical Department of Mesta Machine Co. and by 1919 was superintendent of the Open Hearth Department. In 1923, he became superintendent of the No. 2 Open Hearth Department at the Indiana Harbor Works of Inland Steel Co. In 1937, he was appointed assistant general superintendent there and, in 1945, advanced to general superintendent. He was named vice president in charge of operations at Newport Steel Corp. in 1951 and was elected executive vice president and general manager in 1955. He also was executive vice president, Steel Division, Merritt Chapman & Scott Corp. for one year beginning in 1955. When the assets of Newport Steel were acquired by Acme Steel Co. in 1956, Mr. Miller was appointed vice president and general manager at Newport and has served in that capacity since then.

Paul H. Devaney has been appointed to the newly-created position of general manager of production for Jones & Laughlin Steel Corp. He had previously served as works manager at J&L's Aliquippa Works for the past 9 years. In his new position, Mr. Devaney will manage operations at J&L's three basic steel plants at Pittsburgh and Aliquippa, Pa., and Cleveland, Ohio. **A. C. Keller** succeeds Mr. Devaney as Aliquippa works manager. He formerly was assistant works manager. **Lawson M. Van Ormer** succeeds Mr. Keller as assistant works manager at Aliquippa. He was formerly superintendent of the Works' Tin Plate Department. **C. T. Snyder** has been named superintendent of the Tin Plate Department, succeeding Mr. Van Ormer. He was assistant superintendent of the department. **Warren L. Cooper,** formerly assistant to the superintendent—Tin Plate Department, has been appointed assistant superintendent, succeeding Mr. Snyder. **Robert**

T. W. HUNTER

F. A. DUDDERAR

J. M. WALSH, JR.

A. P. MILLER

P. H. DEVANEY

A. C. KELLER

L. M. VAN ORMER

D. J. SULLIVAN

H. Smith formerly general foreman—coating and finishing, Tin Plate Department, succeeds Mr. Cooper as assistant to the superintendent.

Mr. Devaney has been a J&L employee since 1924, when he became a millwright helper at the Aliquippa Blast Furnace Department. He was promoted to millwright turn foreman the same year, and, in succeeding years, held positions as general foreman, sinter plant; assistant superintendent, Rectangular Coke Department; assistant superintendent, blooming mill; and assistant superintendent, Open Hearth Department. He was named superintendent of hot rolling mills in 1938. He was promoted to assistant works manager in 1947 and became works manager in 1950. Mr. Keller has been a J&L employee at the Aliquippa Works since 1925. He started as an inspector—investigator in the Metallurgical Department, was named chief chemist in 1931, and in 1936 became steel works metallurgist. He was promoted to assistant superintendent of the Open Hearth and Bessemer Department in 1938 and to superintendent of that department in 1947. He became assistant works manager of the Aliquippa Works in 1950. Mr. Van Ormer has been employed at the Aliquippa Works since 1927 when he started in the Metallurgical Department. He was named assistant works metallurgist in 1940, and works metallurgist in 1947. He was appointed superintendent of the Tin Plate Department in 1952. Mr. Snyder started in the Tin Plate Department of the Aliquippa Works in 1929. He was appointed assistant superintendent in 1951. Mr. Cooper has been a J&L employee since 1938, when he started in the Metallurgical Department. He also held a series of positions within the Tin Plate Department and was named general foreman—cold rolled sheet in 1951. He was named assistant to the superintendent in 1953. Mr. Smith started at J&L's Aliquippa Works as an iron chemist in 1939. He was named assistant tin plate metallurgist in 1948, and was appointed general foreman—coating and finishing in 1952.

Daniel J. Sullivan has been named superintendent of the blooming and billet mills at Republic Steel Corp.'s Chicago plant. He succeeds **R. F. (Rem) Lavette,** a veteran of 50 years with Republic and its predecessor companies in Chicago. Mr. Sullivan joined Republic in 1943, as turn foreman in the 44-in. blooming mill at Chicago. He was appointed general foreman of the blooming and billet mills in 1944, and assistant superintendent in 1947.

George Grosvenor has been appointed superintendent of steel production at the Pueblo, Colo., plant of Colorado Fuel & Iron Corp. At the same time, **Iver Ellingboe** was named superintendent of the Open Hearth Division, and **Charles G. Campbell,** superintendent of the Basic Oxygen Division. **John D. Yoxtheimer** was appointed assistant superintendent of the Open Hearth Division.

Francis J. Todd has been appointed assistant superintendent of the melt shop at Republic Steel Corp.'s Chicago, Ill., district steel plant. He joined Republic as a technical operating trainee in 1948, at the company's Buffalo, N. Y., District plant. In 1951, he was named assistant general foreman in the Open Hearth Department at the Buffalo plant. He was promoted and transferred to the company's Chicago District plant in 1959, as general foreman.

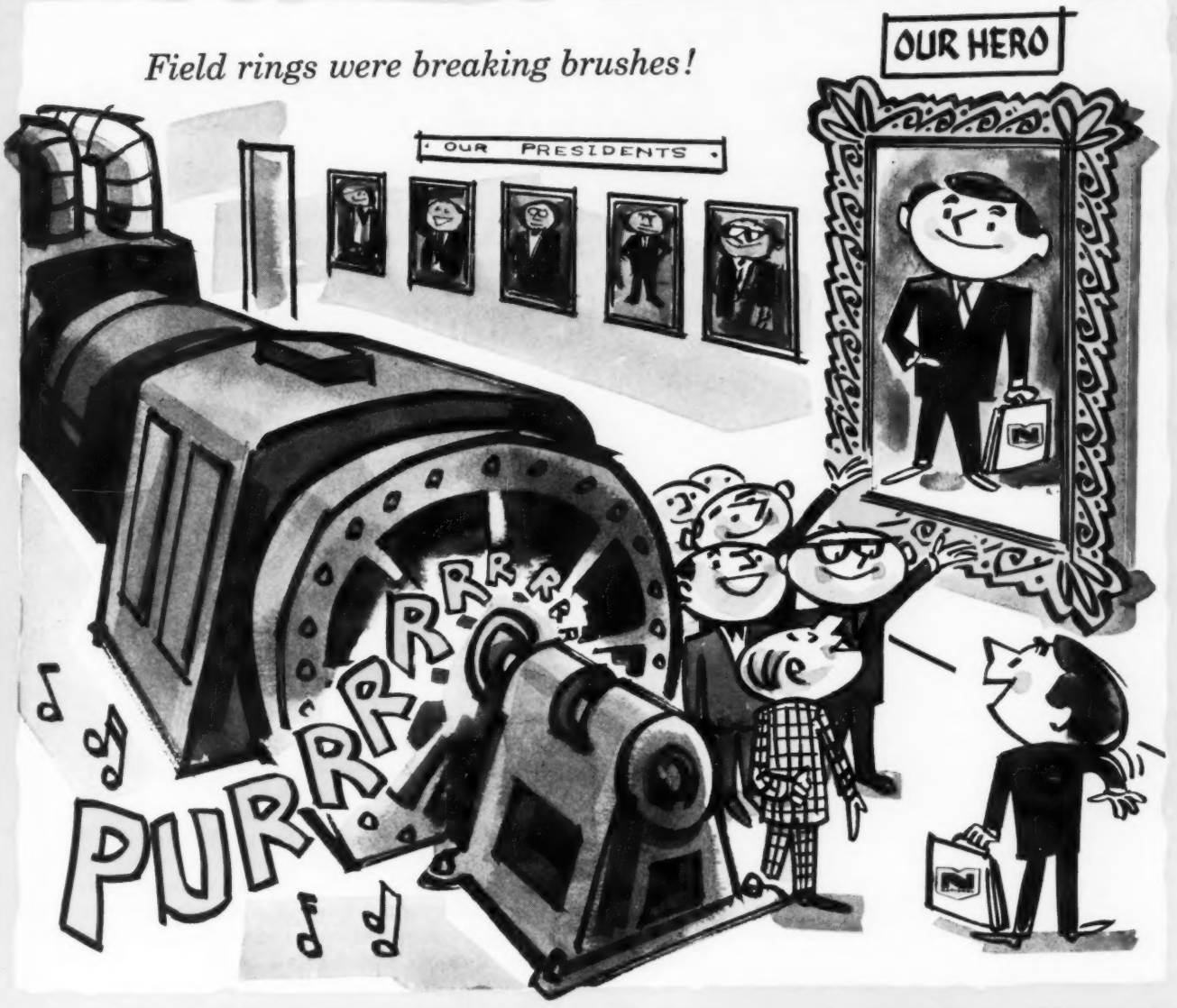
Clifford H. Price was named chief engineer and **Mills C. Tourtellotte** assistant chief engineer of Gulf States Tube Corp., a wholly-owned subsidiary of Michigan Seamless Tube Co. Mr. Price has been plant engineer since 1958, when he was transferred from Michigan Seamless to the Texas plant. Mr. Tourtellotte was formerly a Michigan Seamless design engineer.

Harold F. Burttram has been appointed assistant superintendent of the blooming mill at the Gadsden, Ala., plant of Republic Steel Corp. He has been employed at Republic's blooming mill since 1941. After working as an ingot buggy operator and pit recorder, he entered Republic's technical operating training program in 1948, completing the course in 1950. He was then promoted to mechanical foreman at the blooming mill and worked in that capacity until 1956 when he became a turn foreman in blooming mill operations.

R. L. Frederick was named to the new position of executive director—International Division, The Timken Roller Bearing Co. Mr. Frederick will be in charge of co-ordinating Timken's international operations. He started with Timken in 1940 as a factory trainee, was promoted successively to assistant superintendent of labor relations, superintendent of labor relations, director of labor relations and assistant to the president before being named to his present position.

Louis W. Jander, formerly assistant general sales manager, has been promoted to general sales manager

Field rings were breaking brushes!



NATIONAL TRADE-MARK **stopped brush breakage!**

DOWN-TIME COULD HAVE COST THIS POWER COMPANY A FORTUNE!

"RED" BLACKBURN

PROBLEM: Threading and grooving of the steel field rings on giant turbine generators.

RECOMMENDATION: "National" brush grade 634.

RESULTS: This brush eliminated threading, grooving and resisted breakage and chipping when applied to eccentric rings.

Contact your "National" Brush Man

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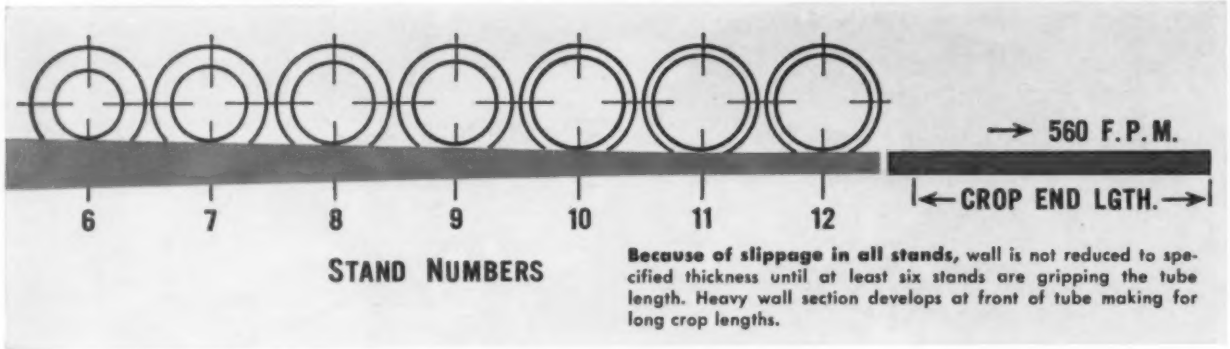
TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

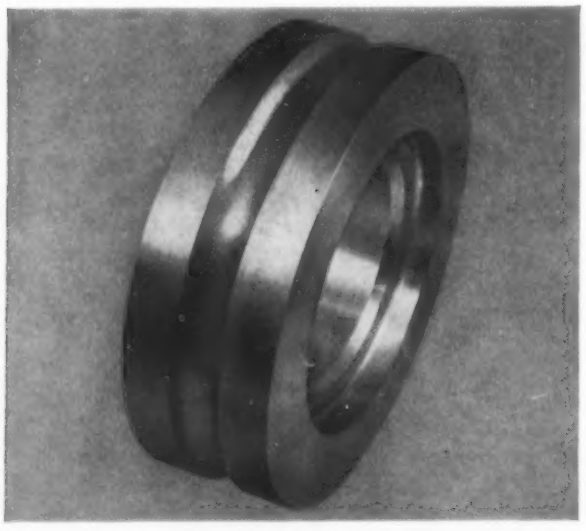
Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

Balancing bite, slip and wear in stretch-reducing rolls



Because of slippage in all stands, wall is not reduced to specified thickness until at least six stands are gripping the tube length. Heavy wall section develops at front of tube making for long crop lengths.

From the roll maker's standpoint, the stretch-reducing mill is full of contradictions. The rolls must provide good "bite" on the tubing, without squeezing it so hard that it buckles. Actually, this is impossible in a pair of stands: in practice, operators have found that at least six stands are needed before the mill starts to produce any reduction in the tube wall. In other words, so much slippage occurs that the tube length is not being stretched at all before the entering end is gripped by the rolls in the sixth stand.



Roll for early stand of a stretch reducing mill, showing pass. Wear is most severe at sides of passes where slippage is at a maximum.

The greater reductions taken in this type of mill as compared to a sinking-sizing mill, combined with the large amount of slippage, make it imperative that the rolls used show good and uniform hardness penetration. Naturally, extremely high hardness is out of the question because of the necessity for good "bite" in order to develop the tension that stretches the tube. However, uniform hardness over the entire pass makes for even wear, easier adjustment as wear increases, and finally, longer runs before redressing becomes necessary.

Actually, our experience with rolls in this kind of service indicates that wear is most severe at the edges of the pass. Hence, any tendency toward lower hardness at the center of the pass may actually make for a balanced rate of wear over the entire working surface.

Mack-Hemp *Technigrain*® low alloy iron rolls consistently turn in enviable performance records in stretch-reducing mills. In the larger newer mills we recommend our nickel alloy iron *Nironite*® annealed to a low hardness for best possible wearing qualities. Both types are carefully controlled to assure an even hardness penetration, and keep slippage to the necessary minimum even with the relatively high reductions taken in each stand.

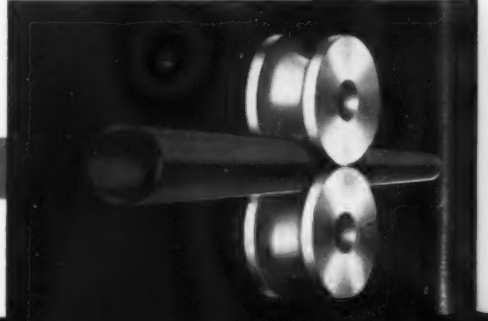
Mack-Hemp rolls are serving in every type of mill, from the oldest to the very latest designs. As a result, we are adding constantly to our store of data on roll performance. We are pleased whenever roll users call upon us for advice on matters of roll use and selection . . . if you have a specific problem why not 'phone or write us today?

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



of Yale Materials Handling Division, The Yale & Towne Manufacturing Co. He joined the Yale sales organization in 1956 as a regional sales manager, being promoted to assistant general sales manager in 1958. Previously he was general sales manager of the Disston Division of H. K. Porter Co.

Ellis B. Gardner has been appointed executive vice president of Hewitt-Robins Inc. Mr. Gardner joined the company in 1946. Since 1955, he has headed the company's Foam Products Division. Before joining Hewitt-Robins he had been associated with General Electric Co. in Schenectady, N. Y., for five years. **Pitt B. Harris** was named as acting general manager, Foam Products Division. Mr. Harris started with the company as a field salesman in 1947. He subsequently became regional sales manager and then sales manager of the Foam Products Division, the position he held at the time of his new appointment.

Henry J. Wallace has been appointed president of National Tube Division, United States Steel Corp. He succeeds **John E. Goble** who has retired. At the same time, it was announced that **William F. McConnor,** executive vice president of the division since 1950, has retired and that **Edmund G. Price** succeeds him. **Truman H. Kennedy** succeeds Mr. Price as vice president of operations, and **Arthur W. Thornton** becomes general superintendent, Lorain Works, succeeding Mr. Kennedy.

Mr. Goble was first employed by Oil Well Supply Co., a subsidiary of U. S. Steel, in 1925, as South American sales representative. In 1936, he was transferred to National Tube as vice president in charge of sales. He was elected president of National Tube Co. in 1946. Mr. Wallace started his career with National Tube in 1928 as an assistant chemist at Ellwood City Works. He was appointed vice president in charge of sales in 1950, the post he held at the time of his present appointment. Mr. McConnor joined National Tube's engineering department in 1917 and, in 1920, was made assistant general superintendent of the large pipe department at Christy Park Works. He was appointed general manager of sales in 1936 and elected vice president in charge of sales in 1946. Mr. Price was employed in the Blast Furnace Department at Lorain for five years before being transferred to South Chicago Works of the old Illinois Steel Co. as blast furnace foreman. From 1933 to 1944, Mr. Price served successively at Lorain as superintendent of blast furnaces and docks, assistant general superintendent and general superintendent. He became vice president of operations in 1948, the position he held at the time of his present appointment. Mr. Kennedy joined National Tube as assistant blast furnace superintendent of its National Works in 1940. He was named superintendent of blast furnaces in 1941, assistant general superintendent of the plant in 1946, and general superintendent in 1948, serving in that capacity until his transfer in 1957 to Lorain Works of the division as general superintendent, the post he held at the time of his present appointment. Mr. Thornton was with Weirton Steel Co.'s Metallurgical Department, in 1931. Two years later, he moved to the Duquesne Works of Carnegie-Illinois Steel Corp., and in 1934 was transferred to National Tube as steel works metallurgist at National Works. He remained at National Works for 20 years, serving finally as assistant general superintendent of the plant. Mr. Thornton was moved to the Pittsburgh headquarters of National Tube in 1954, when he was appointed assistant to the vice president of operations, the position he held at the time of his most recent appointment.

J. A. Pierce of Harbison-Walker Refractories Co. has been promoted to manager of technical sales. Mr. Pierce has been a member of the Technical Sales Department since 1951.

Howard C. Meyers, Jr., was appointed to the position of director of metallurgy of the Midvale-Heppenstall Co. Mr. Meyers has been associated with the company for almost 30 years, starting as a clerk in the Armor Plate Department in 1930, and progressing to assistant to the vice president and then to general superintendent of testing and inspection.

Frederick Johnston has been appointed division engineer for the Container Division of Jones & Laughlin Steel Corp. Mr. Johnston comes to J&L from Crown Cork & Seal Co., where he was supervisor of project and equipment engineering.

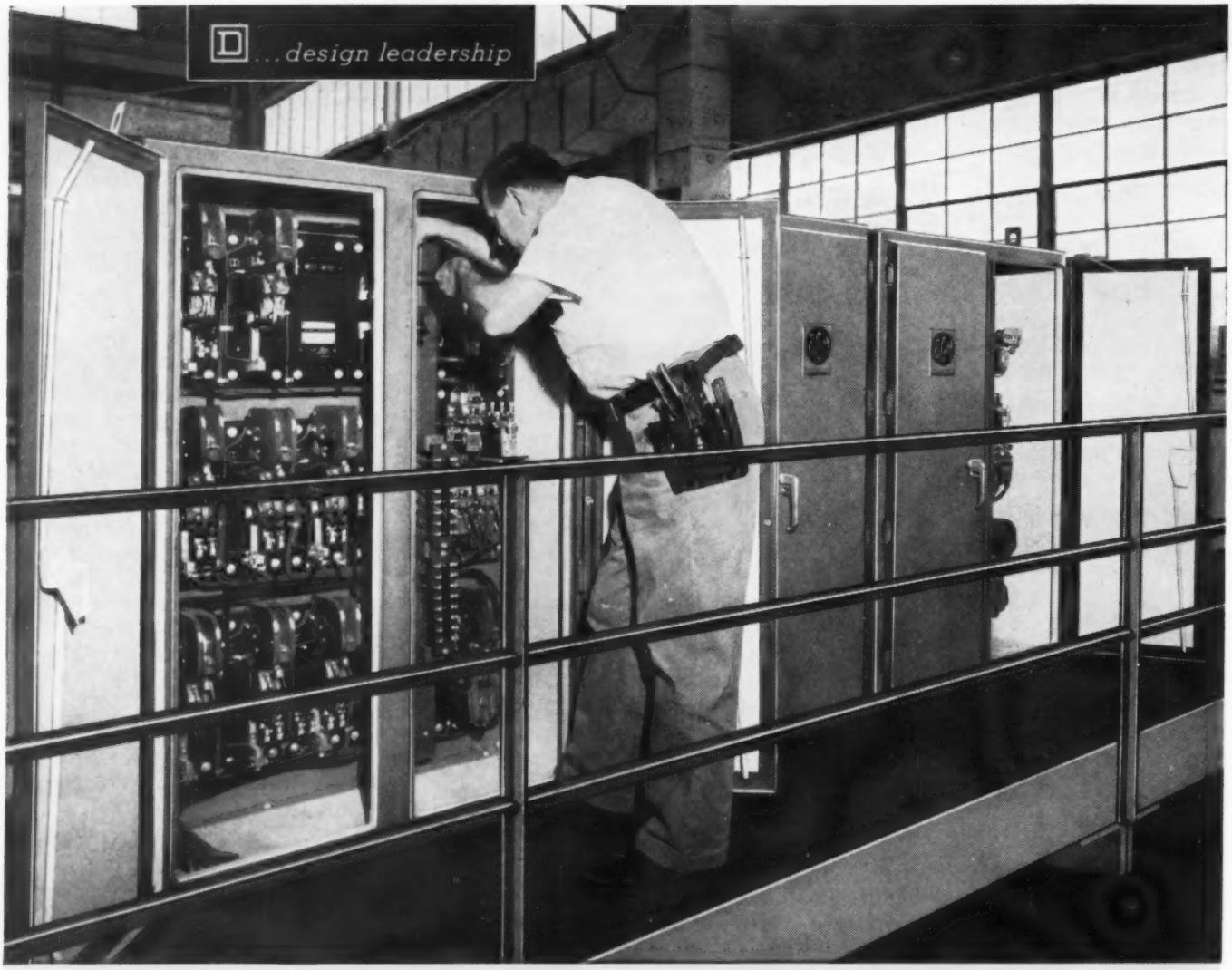
Philip F. Gray, Jr., and **Thomas R. Elmblad** have been named managers of the Boston, Mass., and Cleveland, Ohio, district sales offices, respectively, of Whiting Corp. Mr. Gray moves to his new position from the sales staff of Whiting's New York domestic office and Mr. Elmblad from the Pittsburgh, Pa., office. **J. A. McGlone** has been appointed sales manager of Whiting's Trambeam overhead material handling systems. He moves from Chicago, Ill., sales to the home offices at Harvey,

H. J. WALLACE

E. G. PRICE

T. H. KENNEDY

A. W. THORNTON



NEW! EC&M Front-Connected DC Control reduces catwalk width up to 20 inches

• When space is important, EC&M front-connected control can save you up to 20 inches of catwalk width. Moreover, the controllers are 10% to 15% lighter, can be backed up against girders. The result—a reduction in crane weight.

These new front-connected controllers provide the easiest maintenance of any available. All wiring and control components are accessible from the front, with ample working space inside the cabinet.

You get extra safety, too. Control components are mounted on insulated bases which in turn are mounted on panel studs projecting from the rear of the cabinet. The result is maximum insulation to ground.

EC&M front-connected control is available for single-motor DC drives up to 225 hp, with 2, 3 or 4 decks to suit headroom requirements. Includes exclusive Wright dynamic lowering circuit which gives maximum hook speed without danger of overspeeding.

Write for Bulletin 6121. Square D Company, EC&M Division, 4500 Lee Road, Cleveland 28, Ohio

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4160

C. F. BEUKEMA

C. G. HOGBERG

H. I. SMITH

J. R. PHILIPS, JR.

Ill. **B. L. Heinen,** formerly of Whiting's Houston, Texas, office, has been transferred to Chicago. Mr. Heinen joined Whiting in 1950 in the sales training program. **R. A. Rogers** has been transferred from Chicago to Whiting's Charlotte, N. C., district office. Mr. Rogers joined Whiting in 1957 as a sales trainee.

Christian F. Beukema has been appointed president of Oliver Iron Mining Division of United States Steel Corp. In his new post, Mr. Beukema succeeds the late **Rudolph T. Elstad.** For the past five years, Mr. Beukema has been president of United States Steel's Michigan Limestone Division. He began his career with U. S. Steel in maintenance and construction engineering at the Calcite Plant of Michigan Limestone, Rogers City, Mich. In 1949, Mr. Beukema was transferred to Pittsburgh, Pa., as special assistant to U. S. Steel's vice president—raw materials and was made director of planning in the raw materials division in 1951. He returned to Michigan Limestone in 1953 as general manager of operations at the Division's headquarters in Detroit. Mr. Beukema was appointed vice president of Michigan Limestone in 1954, and president in 1955.

Carl G. Hogberg has been appointed president of Michigan Limestone Division, succeeding Mr. Beukema.

Mr. Hogberg began his employment with U. S. Steel in 1935 as a blast furnace apprentice at South Chicago Works. He was transferred to Pittsburgh in 1941, where he was concerned primarily with blast furnace raw materials development, and the quality control problems in their production.

Mr. Hogberg moved to Detroit in 1955, as assistant to the vice president of Michigan Limestone Division. He was named assistant vice president a year later, and in 1957 became vice president.

H. I. Smith has been appointed superintendent of the Rolling Mills Department, Pittsburgh Works, Jones & Laughlin Steel Corp. He formerly was assistant superintendent. He succeeds **James L. McHugh** who is retiring after 32 years in the Pittsburgh Works Rolling Mills. **Richard C. Ehrhardt** has been named assistant superintendent of the rolling mills. He formerly was general foreman. Mr. Smith has been a J&L employee since 1919 when he started as a recorder in the rolling mill. He held a series of positions in that department and was named general foreman in 1946. He became assistant superintendent in 1951. Mr. McHugh started his J&L career in 1927, as a rolling mill foreman. He has been superintendent of rolling mills since 1950. Mr. Ehrhardt has been a J&L employee since 1947. He started in the Order Department in J&L's general office and, then in the Design Engineering Department of J&L's Aliquippa Works. He was transferred to the Pittsburgh Works in 1952 and was named assistant general foreman of the 10-in. bar mill in 1954. He became general foreman in 1955 and general foreman of the Pittsburgh Works rolling mills in 1958.

J. R. Philips, Jr., has been named assistant district manager at Republic Steel Corp.'s Youngstown, Ohio, plant. He succeeds **W. I. Manley** who has retired after 43 years with the company. Mr. Philips joined the company in Gadsden, Ala., in 1937 as a schedule and service clerk. He became assistant manager of the Order Department in 1943 and two years later was promoted to manager. He moved to Youngstown in 1949 as manager of the Order and Shipping Department. In 1959, he was appointed general superintendent, the position he held until taking over his new duties. Mr. Manley joined Republic in Youngstown as a machinist in 1915. He was made machine shop foreman at the Bessemer plant in 1929 and master mechanic of the electric weld tube mill in 1931. The following year he was named assistant superintendent of the Mechanical Department, and in 1936 was promoted to superintendent. He served as assistant district manager since 1946.

William E. Schnitgen has been made superintendent of Republic Steel Corp.'s Hot Strip Finishing Department at Warren, Ohio, and **Harold O. Ripple** has been appointed superintendent of the Steel Conservation and

W. E. SCHNITGEN

H. O. RIPPLE

Quality Department. Mr. Schnitgen has been assigned to the Warren plant since joining the company in 1948 as a technical operating trainee. He was made an assistant foreman in the Silicon Department in 1950 and assistant millwright foreman in the Mechanical Department in 1951. He also served as district lubrication engineer and in 1952 was appointed assistant superintendent of the Silicon Department, the position he held until receiving his new assignment. Mr. Ripple, a veteran of 26 years at the Warren plant, joined the company in 1933 as a cost and production clerk in the Accounting Department. He subsequently served as chief clerk for the Coke, Blast Furnace and Open Hearth Departments. In 1948, he was made assistant superintendent of quality control and in 1957 became chief clerk for the district manager. He was named assistant superintendent of the Steel Conservation and Quality Department in 1959.

Fred H. McCurdy was elected to the offices of chairman of the board and chairman of the executive committee, The Brooks Oil Co. Mr. McCurdy has been president of the company for the past 12 years. He started with Brooks in 1932 as a salesman. **W. W. Ward** has been elected president and chief executive officer. Mr. Ward has been a director and secretary for the past eight years. He started with the company in plant production in 1946. **R. T. Joyce** has been elected vice president in charge of operations and secretary. Mr. Joyce has been with Brooks for 25 years. **Alfred A. Paul** was elevated to vice president, engineering—sales from the position of manager, engineering—sales. Mr. Paul started in 1940 as a salesman.

S. D. VAUGHAN

B. K. BUGG

Sam D. Vaughan has been appointed superintendent, mechanical shops and field crews, at Kaiser Steel Corp.'s Fontana, Calif., plant. Mr. Vaughan first came to Fontana while working for Koppers Co. on the construction of the Kaiser plant in 1942. He joined the company in 1943 as a general foreman, mechanical maintenance, East. He rose to assistant superintendent, mechanical shops and field crews; and in 1959, became acting superintendent. He has also been in charge of all blast furnace relines.

Bill K. Bugg has been promoted to superintendent of the plate and hot strip mills at Republic Steel Corp.'s Gadsen, Ala., Plant. He formerly was assistant superintendent of the Plate—Hot Strip Department. He succeeds the late **E. H. Callahan.** Mr. Bugg joined the Gadsen plant in 1934 in the blooming mill. He worked in the sheet mill and then in the plate mill and was mill

EXECUTIVE REPORT #7

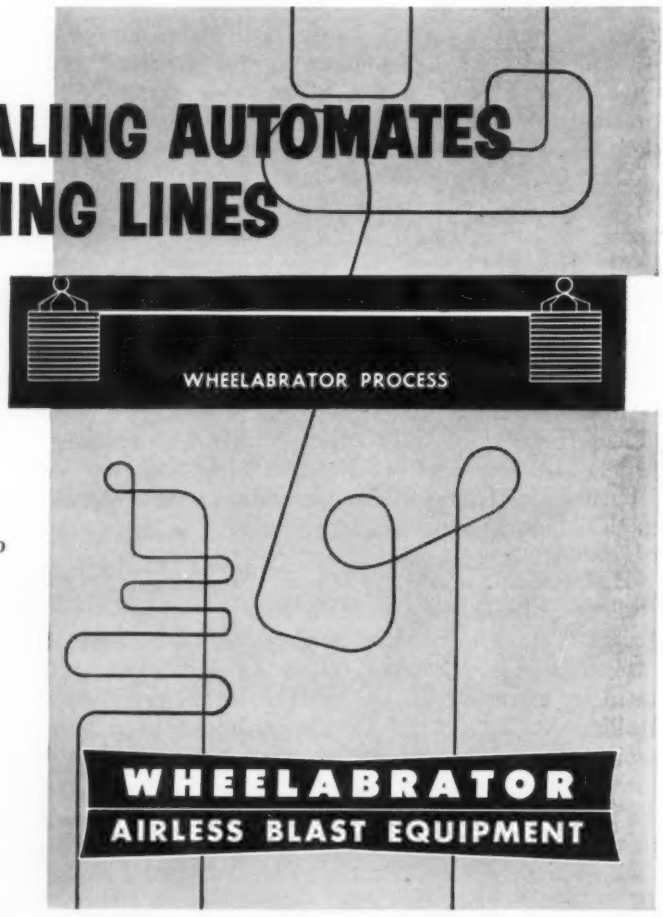
STRAIGHT-LINE DESCALING AUTOMATES WIRE AND BAR DRAWING LINES

Wheelabrator abrasive blast descaling brings new automation to wire products manufacture, with substantial savings in time and labor. Whereas batch pickling requires multiple handling operations, this mechanical descaling process involves handling coils only once or twice.

Rod can be straightened, cleaned, coated, drawn and cold headed in one continuous, straight-line operation. Single or multiple strands can be cleaned at speeds up to 600 fpm. The savings through eliminating acid pickling and multiple handling are enormous.

Take advantage of WHEELABRATOR'S engineering experience in wire descaling

Wheelabrator's unequalled experience in blast descaling of wire is at your service. Send for Bulletin 148-D illustrating the Wheelabrator automated wire drawing method. Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Ind. Canadian Division: P. O. Box 490, Scarborough, Ont.



provider from 1942 to 1946, when he became assistant superintendent.

P. B. Harwood, a senior vice president; **J. L. Defandorf,** general supervisor of engineering; and **C. T. Evans,** consulting engineer, have retired from Cutler-Hammer Inc. Mr. Harwood joined the company in 1917, and became Cutler-Hammer's manager of engineering in 1939. In 1945 he was elevated to engineering vice president, and was appointed as a senior vice president last year. Mr. Defandorf also started with Cutler-Hammer in 1917. He was advanced to supervising engineer in 1927, a post he held until appointed general supervisor of engineering in 1945. Mr. Evans, has been with the company since 1908 as a development engineer.

Edwin H. Burke has been appointed vice president of engineering for The Morgan Engineering Co. Prior to the appointment, Mr. Burke was director of engineering in charge of engineering designs of cranes and steel mill equipment, proposal and research, and development engineering. He formerly worked for the United Engineering & Foundry Co., and Crucible Steel Co. of America at Midland, Pa.

R. G. Birkin has been appointed sales manager of the Heavy Machinery Division, The Cleveland Crane & Engineering Co. Mr. Birkin has been with the company in various sales capacities for 33 years. In recent years he has been Eastern district sales manager of the Heavy Machinery Division. He replaces **C. H. Saiter** who is retiring from active service, but will continue as a consultant for special projects.

E. H. BURKE

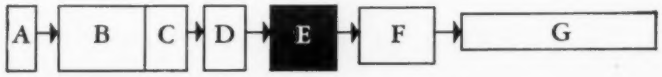
R. G. BIRKIN

Richard Finn has been assigned to The Torrington Co. sales office at Tulsa, Okla. At the same time **Harvey M. Mauel** was assigned to the Eastchester, N. Y., office, **Robert F. Deacon** to the Pittsburgh, Pa., office, and **John W. Stout** to the Philadelphia, Pa., office.

George D. Griffiths, former manager of roll sales, has been promoted to assistant vice president, roll sales, The Ohio Steel Foundry Co. **Charles L. Flanigan,** former assistant manager of roll sales, has been promoted to manager, Eastern roll sales, and **Frank B. Stauffer** has been promoted from sales engineer to manager, Western roll sales.

George F. Lytle has been named manager of Whiting Corp.'s newly formed Pressuregrip Division. "Pressuregrip" is the brand name of a new vacuum lifting system

EXECUTIVE REPORT #8



ROD DESCALING, COATING AND DRAWING IN ONE CONTINUOUS OPERATION

at Lamson & Sessions Co.

In their new and ultra-modern Cleveland plant, Lamson & Sessions Co. has proved that Wheelabrator straight-line blast descaling is the shortest distance between hot rolled rod and wire profits.

Their automated descaling line starts with hot rolled rod on a payoff reel (A), provides a portable welding station (B) for joining successive coils, passes through a snarl switch (C) and straightener-leveler (D), through the Wheelabrator blast descaling cabinet (E), through coating and drying equipment (F) and to the draw block and re-coil unit (G) — all in a straight line, with no interruption and no intermediate handling.

This efficient method is made possible by the speed and thoroughness of Wheelabrator airless blast descaling, which removes all scale or rust down to virgin metal, without acid pickling, at speeds as dictated by subsequent operations.

WHEELABRATOR method lets you automate your wire and bar drawing lines

With the Wheelabrator method, you can blast clean in line with patenting, cold drawing and cold heading. To see how many leading producers are saving with this system, write for Bulletin 148-D. Wheelabrator Corp., 396 S. Byrkit St., Mishawaka, Ind. Canadian Division: P. O. Box 490, Scarborough, Ont.

for materials handling, recently announced by the firm. Mr. Lytle, before joining the Whiting Corp., formed and headed the Vac-U-Lift Co. of Salem, Ill., which later was sold to the Ziegler Corp.

Fred J. Truesdale has been named manager of the Service and Maintenance Department at Weirton Steel Co. division of National Steel Corp. to succeed **George L. Campbell** who has retired. At the same time, the following promotions in the Service and Maintenance Mechanical Department were announced: **James A. McConnell** as assistant manager; **Vincent V. Curtis** as superintendent; and **George M. Pearson, Jr.,** as assistant superintendent.

Mr. Campbell, who retires after nearly 45 years of service with Weirton, began his employment in 1915 in the tin mill, and following a series of promotions was named master mechanic in that department. In 1927, he became general foreman of the steel works machine shop, eight years later was named assistant superintendent of the company's Mechanical Department, and in 1945 was promoted to assistant manager of service and maintenance. He became manager in 1951. Mr. Truesdale began his employment with Weirton in 1926 as a clerk in the Electrical Department. He successively served as a draftsman in electrical engineering, as assistant superintendent of the Mechanical Department and then assistant to the manager of service and maintenance. He was named assistant manager of service and maintenance mechanical 10 years ago and held that position until his current appointment.

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STRAINERS

. . . for efficient removal and disposal of suspended particles from raw or process water and other liquids

- ✓ Over 1000 installations
- ✓ 2″ to 48″ pipeline sizes
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Write today for Bulletin 501.11 and list of installations

S.P. KINNEY ENGINEERS, Inc.
CARNEGIE, PENNSYLVANIA

F. J. TRUESDALE

C. S. FISHER

C. S. Fisher has been made Pittsburgh district representative for Steel Plant Equipment Corp., of Eagleville, Pa. This company has just completed a new plant for the manufacture of various kinds of rollers, including plastic covered rolls for continuous strip and wire processing lines.

Hughes W. Ogilvie has been named manager—marketing for General Electric Co.'s Medium Steam Turbine, Generator and Gear Department. He succeeds **Harry W. Lawson** who has been named manager—user industries sales for the central district of General Electric Co.'s Apparatus Sales Division with headquarters in Chicago, Ill.

Walter L. Treadwell has been appointed assistant general manager of the Pacific Coast Engineering Co. Mr. Treadwell was formerly industrial engineering manager. Prior to that position he was assistant chief engineer. He joined Paceco in 1951, as senior mechanical engineer.

Obituaries

Henry Bedinger Rust II, a vice president and director of The Rust Engineering Co. and its affiliates, died January 8.

Robert E. Moughton, formerly chief engineer, Edgar Thomson Works, United States Steel Corp., Braddock, Pa., died in December.

Kenneth E. Dinius, formerly works chief engineer, South Works, United States Steel Corp., was killed in an automobile accident, December 16. Mr. Dinius was a life member of the AISE, had served on many committees, and in 1933 served as chairman of the Chicago district section.

F. R. Burnette, Sr., died January 12. Mr. Burnette was formerly assistant executive vice president for engineering and raw materials of the United States Steel Corp., retiring in 1956.

Leroy R. Valette, vice president and general manager of K. W. Atwater Engineering, Inc., died Dec. 27. Mr. Valette served with U. S. Steel Corp. in Gary, Ind., and with Crucible Steel Co. of America at Midland, Pa. He joined Atwater Engineering in 1953.

John C. Pangborn, co-founder of Pangborn Corp., died December 24. He was 75.

John Verson, who with his brother founded the Verson Allsteel Press Co., died January 8.

No. 5 Electrolytic Tinning Line, Gary Sheet and Tin Mill, U. S. Steel Corporation

Wean, U. S. Steel and Tinning . . .

Twenty-two years ago the world's first commercial production electrolytic tinning line went into operation. Using the "Ferrostan" process, which was developed by U. S. Steel, the line was engineered by Wean and technical personnel of U. S. Steel.

The years of experience and constant progress since that initial installation are incorporated in this "Ferrostan" line. It features the most modern advances in automated tinning line design: cleaning and plating tanks are elevated to reduce basement complexity and simplify maintenance; both recoiling and shearing equipment are provided to satisfy all customer requirements; and an electronic data-logging system provides a "process profile" of all coiled tin plate.

Wean is justly proud of its many years of leadership in tinning line technology: 75% of all electrolytic tin plate produced is the result of Wean's *creative engineering.*

THE WEAN ENGINEERING COMPANY, INC. • WARREN • OHIO

Former bearings took a day . . . this bearing replaced in 1 hour and a half!

Here is one of several 4-7/16" shaft size split roller bearing pillow blocks installed on large, high speed fans at the Kaiser Aluminum & Chemical plant in Baton Rouge, Louisiana. Split roller bearings were purchased by Kaiser after thorough study and on the recommendation of our sales engineers! Our recommendation was based on the ability of these bearings to stand up under constant use and because it is split right-down-to-the-shaft, removal is both simple and fast.

Shown above is Maintenance General Foreman, Ivy Ingram, with the bearing his crew replaced in only one hour and a half. It formerly took many more hours to pull the sheave or coupling, pull the bearing, dress the shaft and install a new bearing. With this new split bearing, they simply removed six cap bolts and went to work.

We are authorized distributors for all the bearings we sell. They come to you in the manufacturers' boxes guaranteed by the maker and our company. Ask for our recommendation on all bearing requirements - There's a branch near you giving fast service 24 hours a day!

Providing bearing service in the North ➤ **BEARINGS, INC.**

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Hamilton • Lima • Lockland • Mansfield • Painesville • Toledo • Youngstown Zanesville • **INDIANA:** Ft. Wayne • Indianapolis • Muncie • Terre Haute • **PENNSYLVANIA:** Erie • Johnstown • Philadelphia • Pittsburgh • York **WEST VIRGINIA:** Charleston • Huntington • Parkersburg • Wheeling • **NEW JERSEY:** Camden **NEW YORK:** Balanrol Corp., Buffalo • Niagara Falls • **MARYLAND:** Baltimore • **DELAWARE:** Wilmington

and

in the South ➤ **DIXIE BEARINGS, INC.**

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Publication Service...

FEBRUARY, 1960

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. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Electrode Pocket Guide

A pocket guide on welding electrodes has been issued by Air Reduction Sales Co. The booklet contains complete information on all types of electrodes available from Airco: mild steel, low alloy, low hydrogen, iron powder, stainless steel, hardfacing, nonferrous and cast iron. Under each electrode listed, a brief description is given together with applications, procedures and pertinent AWS-ASTM data. Charts of recommended Airco electrodes for welding ASTM and trade name steels, and comparison tables for mild steel and hardfacing electrodes of leading manufacturers are also included. The booklet contains a number of important features: an Airco conformance table to government specifications; descriptive write-up of stainless steel iron powder type electrodes; electrode reconditioning guide; and data on new hardfacing electrodes. Electrodes are listed chronologically by AWS classification number. (Form ADC 650)

(2) Cold Rolling Lubricant

A brochure describing their new cold rolling lubricant has been published by Waverly Oil Works Co. Detailed descriptions of experiments on the lubricant are given, and charts showing results of analyses and tests are included. The lubricant as discussed in the booklet was developed for tinplate production, but it is also adaptable for sheet rolling.

(3) Bus Duct Booklet

A booklet describing Westinghouse Electric Corp.'s new high-frequency bus duct is now available. The publication outlines bus duct features and contains a curve of voltage drop at 400 cycles per second plotted against load. (Booklet B-7326-380)

(4) Precision Thread and Form Grinders

The Sheffield Corp. describes their line of precision thread and form grinding machines in a recently published booklet. Machine features and equipment, optional equipment and accessories and specifications are discussed. A diagram of machine's principal parts and illustrations of precision thread grinding applications are also include. (Catalog No. TFG 11-59)

(5) Thermal Insulation

Thermal insulations for all types of commercial and industrial requirements, in applications ranging from −400 F to 3000 F, are described in a new 54-page catalog published by Johns-Manville. The booklet contains six complete sections, each devoted to a specialized group of Johns-Manville thermal insulations. These include industrial and high temperature; plumbing, heating, and air conditioning; refrigeration; insulating firebrick and refractories; finishes and weatherproofing materials; and miscellaneous insulations, including asbestos papers, millboard, felts, blankets and similar products. Individual sections are thumb-tabbed for easy reference. Information on each product consists of an application photo, description, available forms or types, advantages to users, and detailed specification data, including compliance with government specifications and ASTM standards. The type of insulation and its temperature limit are displayed for each product to facilitate location of data, (Catalog IN244A)

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51	ASEA ELECTRIC INC.		Vacuum induction furnaces
52	BABCOCK & WILCOX CO., THE	BULLETIN R-35A	Refractory castables
53	BAILEY CO., WILLIAM M.	BULLETIN V-200	Goggle valves
54	BLAW-KNOX CO., AETNA-STANDARD DIV.		Continuous galvanizing lines
55	BLISS CO., E. W.	BULLETIN 40-B	Rolling mills
56	BRISTOL CO., THE		Radiation pyrometer
57	BUSSMANN MFG. DIV., McGRAW-EDISON CO.	BULLETIN FIS	Dual-element fuses
58	CLEVELAND TRAMRAIL DIV., CLEVELAND CRANE & ENGINEERING CO.	BOOKLET NO. 2008	Overhead materials handling equipment
59	CLEVELAND WORM & GEAR CO., THE	BULLETIN NO. 405	Speed reducers
60	CUTLER-HAMMER INC.	PUB. EA100-C232	Heat-proof safety switches
61	DURALOY CO.	BULLETIN NO. 3150G	High alloy castings
62	EATON MANUFACTURING CO.	BULLETIN D-582	Dynamatic eddy-current equipment
63	FALK CORP., THE		Controlled torque couplings
64	GARLOCK PACKING CO., THE	CATALOG 30	Oil seals
65	GPE CONTROLS, INC.		Electronic controllers
66	HAGAN CHEMICALS & CONTROLS, INC.	BULLETIN MSP-163	Analog computer control
67	HEIL PROCESS EQUIPMENT CORP.		Steam jet agitators
68	HUNT VALVE CO.		Air valve
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71	LEWIS MACHINE CO., THE		Wire straightening machines
72	LINK-BELT CO.	DATA BOOK 2707	Babbitted and bronze bearing blocks
73	MARATHON SPECIALTY STEELS, INC.	BULLETIN EP11	Parts and steels for extrusion presses
74	MARKAL CO.		Markers
75	PORTER, INC., H. K.		Hydraulic rod and bar cutter
76	POST-GLOVER ELECTRIC CO., THE	BULLETIN 410	Master switches
77	R-S FURNACE CO., INC.		Car hearth furnaces, rotary hearth furnaces, pit-type furnaces, etc.
78	SELAS CORP. OF AMERICA		Heat processing
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82	SYNTRON CO.		Material handling equipment
83	WEIGHING & CONTROL COMPONENTS, INC. DIV. OF COMPUDYNE CORP.	BULLETIN 14	Batch-weighing systems
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86	YODER CO., THE		Slitting equipment

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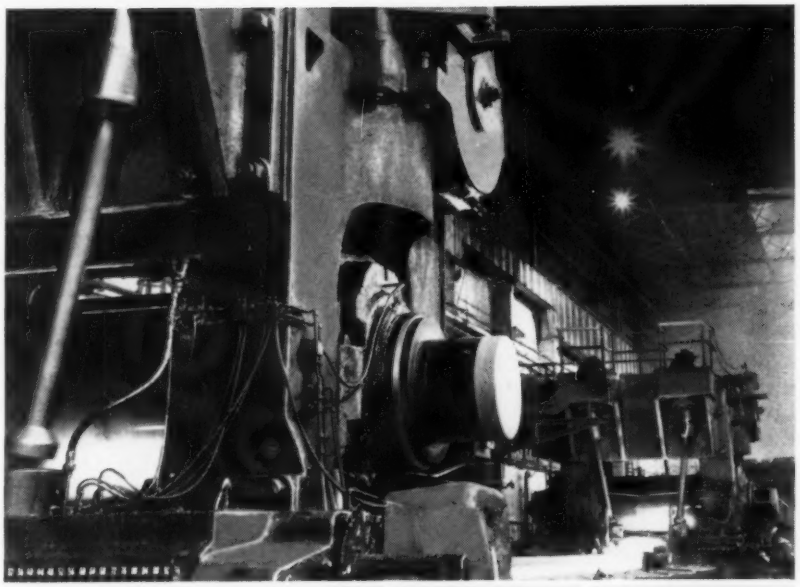
ENGINEERED OIL SEALS for Steel Mills



Model 64

Model 142

Model 53

Model 21 or 23

FULL BEARING PROTECTION IN SEVEREST ATMOSPHERES

Everywhere in steel—on hot and cold strip mills, blooming and structural mills—Garlock KLOZURE* Oil Seals prevent leakage of vital bearing lubrication. And they further prevent damage to the bearings by sealing out scale, spray, dirt, and other foreign matter.

For example, Model 142, a face-type KLOZURE, is designed to seal surfaces perpendicular to shaft . . . keeps water splash and scale out of bearings at the shoulder of mill rolls. Models 64 and 82 are applied to large shafts at normal or high speeds . . . ideal for protecting bearings on back-up and work rolls. Model 53 withstands temperatures up to 250°F at normal or high speeds . . recommended for table rolls. Where equipment can't be dismantled easily, Models 21 or 23 Split-KLOZURES are the choice.

All KLOZURES are oil and grease resistant . . . impervious to water, mild acids, alkalies . . . non-abrasive . . withstand temperatures from −40°F to +250°F. For extreme conditions, Garlock furnishes sealing elements resistant to practically any fluid, and serviceable as high as +500°F.

Sealing Element, case, spring, and adapter on KLOZURES are designed for peak efficiency and durability. Garlock, with 70 years' experience and modern production facilities, manufactures KLOZURE Oil Seals in proper design and to extremely accurate dimensions from materials which are best suited for your application. Engineering skill, vast experience, and mass production know-how bring you the finest oil and grease seals available.

Obtain more information by calling the nearest of Garlock's 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for KLOZURE Catalog 30. The Garlock Packing Company, Palmyra, N.Y.

GARLOCK

Canadian Div.: The Garlock Packing Company of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

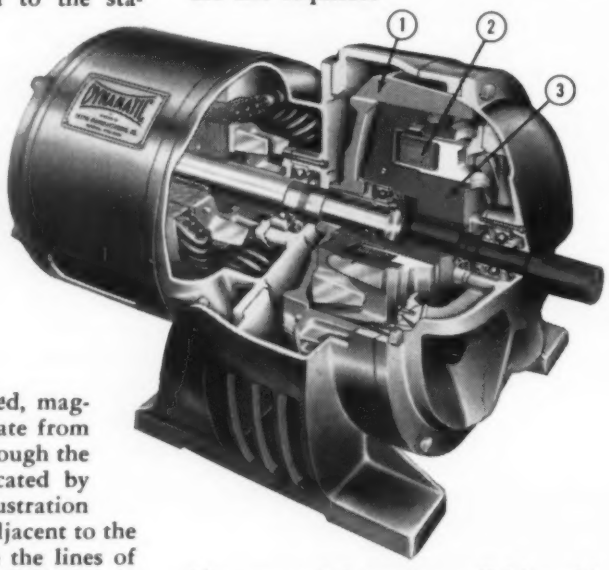
*Registered trademark

HOW DYNAMATIC® Drives Provide Infinitely Adjustable Speed with AC Power

Dynamatic Ajusto-Spede® and Dynaspede® Drives operate from an alternating current power source and are infinitely adjustable from zero RPM to full output speed. Accurate control of output speed is obtained by varying the current in a single field coil.

Each Dynamatic Drive consists of a constant speed AC motor and an eddy-current coupling. Torque developed in the motor is transmitted through the coupling by electromagnetic attraction between its driving and driven members.

The driving member, or drum (1), is mounted on the end of the motor shaft and surrounds the rotor, or driven member (3). The drum is free to rotate independently of the rotor until current is applied to the stationary field coil (2).



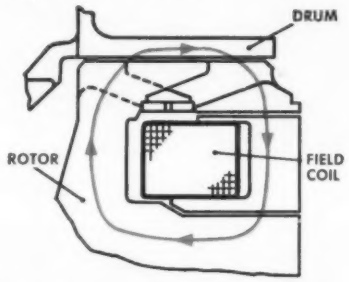
1. Input Drum Assembly
2. Stationary Field Assembly
3. Output Rotor Assembly

As the field coil is excited, magnetic lines of force emanate from the field coil and flow through the rotor and drum as indicated by arrows in cross-section illustration (A). Poles on the rotor adjacent to the smooth drum concentrate the lines of force into localized areas of "high flux" density in the drum's inner surface, shown in illustration (B). As the drum rotates about the rotor, these high flux areas sweep the inner surface of the drum, causing a variation of flux density that generates an eddy-current field in the drum's inner surface. Magnetic attraction between this eddy-current field and the rotor poles causes the rotor to rotate with the drum.

The torque transmitted from the drum to the rotor varies with the current applied to the field coil and with the "slip", or difference in speeds between the drum and rotor. Speed control with eddy-current equipment is obtained with a control system that adjusts field coil current to deliver the required torque at the desired slip.

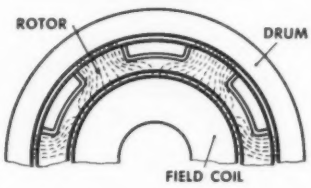
The control systems used with Dynamatic Eddy-Current Equipment operate on alternating current and require no special power source. Because of the low power required for field coil excitation, rectifying of field coil current is easily accomplished electronically. Expensive motor-generator sets are not required.

The control features available with Dynamatic Eddy-Current Equipment include constant speed regulation, acceleration control, torque regulation, cascading of multiple units, inching and threading, and numerous others as required by individual applications. Dynamatic Eddy-Current Equipment is ideally suited to automatic control.



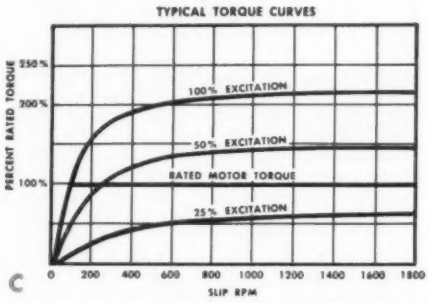
A

Flow of magnetic lines of force through rotor, drum, and stationary field.



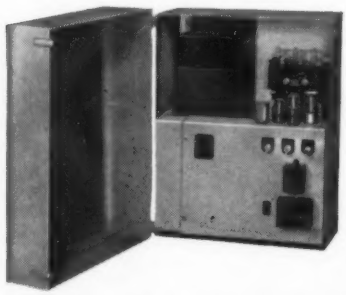
B

Concentration of magnetic lines of force by the rotor poles.



C

Typical torque curves show torque at various values of excitation. The horizontal line is rated motor torque.



D

The electronic control systems used with Dynamatic Eddy-Current Equipment do not require a special power source or motor-generator sets.

EATON®

Send for your copy of Bulletin D-582 which gives detailed information on Dynamatic Eddy-Current Equipment.

EATON — *DYNAMATIC DIVISION*
MANUFACTURING COMPANY
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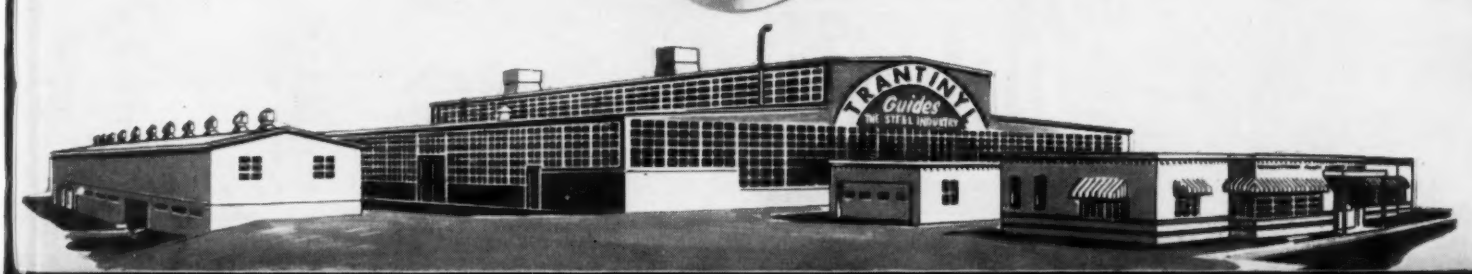
TRANTINYL

guides the steel industry

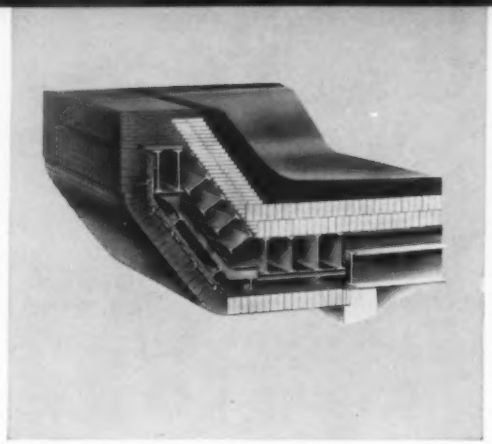


YOUNGSTOWN ALLOY CASTING CORP., • YOUNGSTOWN, O.

ROLLING MILLS: bar, hoop, strip, shape mill guides, and rollers. SEAMLESS TUBE MILLS: guide shoes, rolling mill plugs and rolls, piercer points, etc. ELECTRIC WELD TUBE MILL: forming rolls, planishing rolls, tool holders, etc. • STRAIGHTENING MACHINE GUIDES • HEAT RESISTING CASTINGS

① HELD-UP, HELD-DOWN ROOF

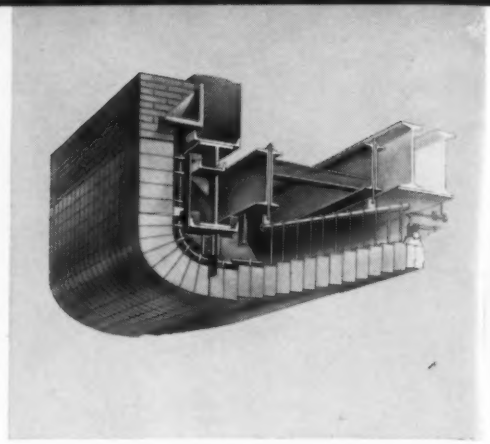
- No roof centers to install.
- Easily hot-patched—Brick layers do entire job. No welding, no cutting.
- Pipe-supported—No special supporting members required.
- Inexpensive hangers—Simple, one-piece wire.
- Standard wedge brick—Wider bearing surfaces. More stability.



② INTERCHANGEABLE SUSPENDED CHILL WALL

- Low cost, simple installation—Adaptable supporting structure.
- Greater expansion flexibility—Tile engaged on bed joints.
- Safe load distribution—Self-supporting castings.
- Tightly sealed joints—Tongue-and-groove clay tile.

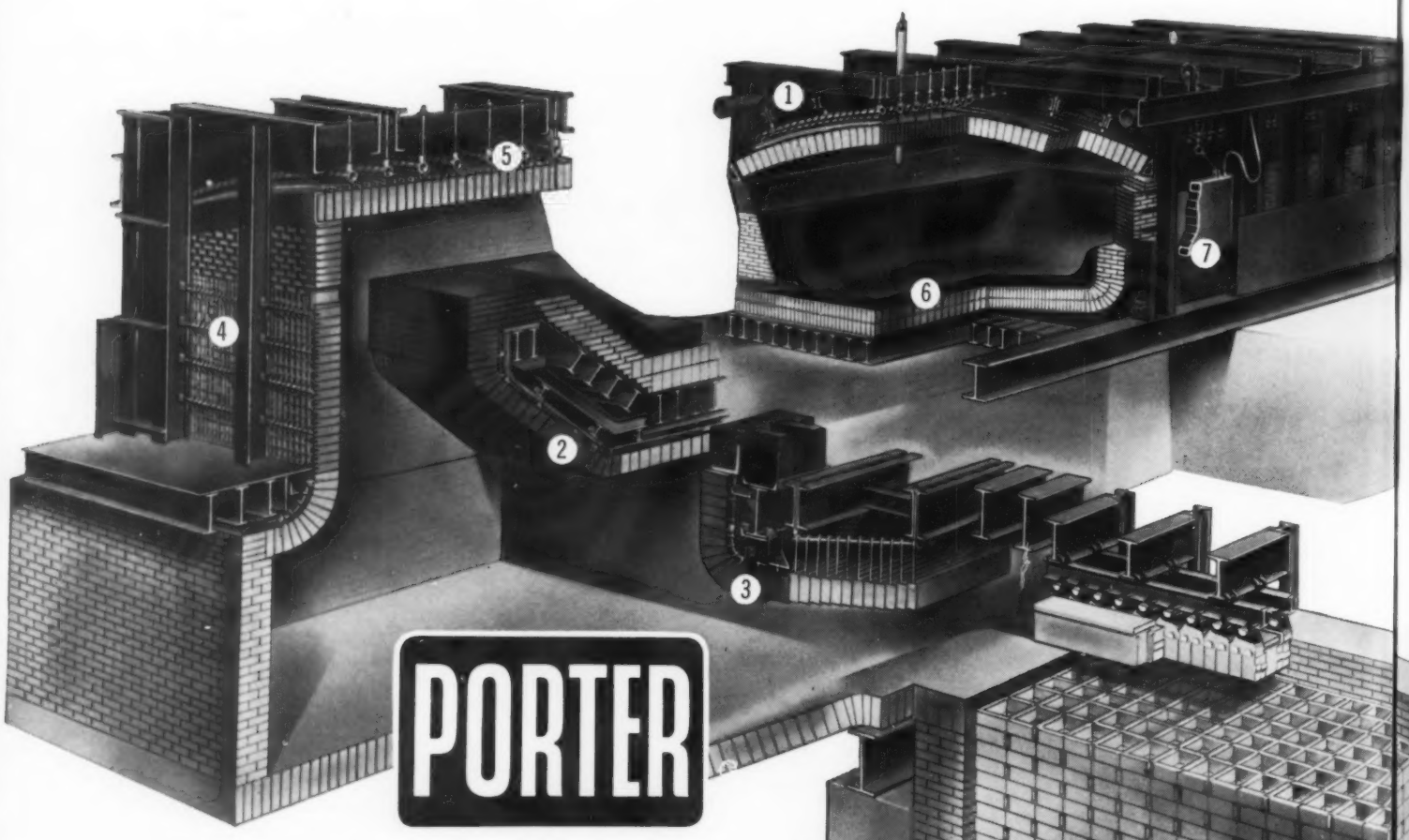
Brick recommended: Either MC-70 Cladex or interchange with Peerlac, 60% alumina.



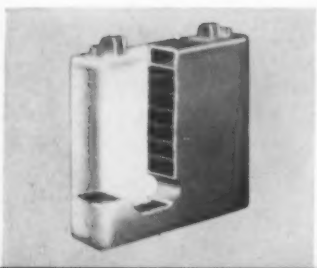
③ INTERCHANGEABLE FAN TAIL

- Pipe-supported—Easily replaced with standard mill supply stock.
- Low-cost, simple installation—Adaptable supporting structure.
- Greatest strength—Fabricated steel nose supports.
- Higher heat resistance—Alloy hangers.
- Tightly sealed joints—Tongue-and-groove clay tile.

Brick recommended: Either MC-70 Cladex or interchange with Peerlac, 60% alumina.



PORTER

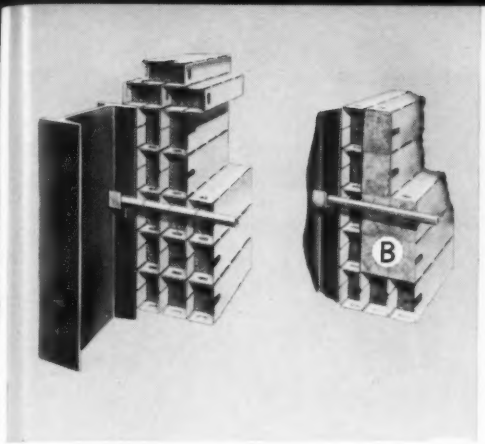


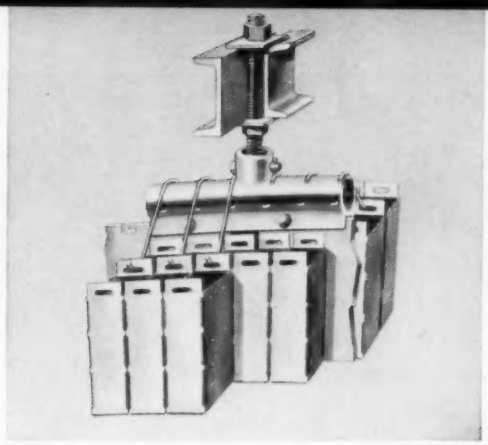
⑦ WATER COOLED OPEN HEARTH DOOR

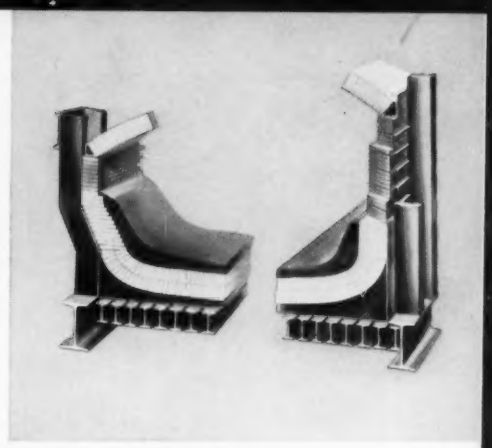
- Long life—Easily installed, easily replaced.

Recommended: Porter Plastikrom for door lining.

* Patents applied for
† T M. applied for







4 ENDWALL CONSTRUCTION

- Air-cooled tabs (4 sides of brick)—More heat conduction for more efficient cooling.
- Refractory reinforcement for hot spots—Extended casings* permit adding refractory material on cold face (B) as hot face wears.
- Cladding with Porter Cladex†—Dimpled construction of casings provide mechanical spacing for expansion.
- Basic strength—Porter construction eliminates need for tie plates.
- Ties and pipe easily reclaimed.
- Simple one-piece hangers—Wall can be dismantled without cutting or burning.

Brick recommended: MC-70 Cladex or other specified chrome and magnesite compositions.

5 AIR CLEANED, AIR COOLED*, TAB SUPPORTED ROOF BRICK

- Built-in air cleaning—Covers entire roof. No hand blowing.
- Controlled cooling over any area—for controlled wear.
- Tab support—Simple, inexpensive.
- Air-cooled tabs—More heat conduction for more efficient cooling.
- Positive support—Tie plate anchored to pipe.
- Inexpensive hangers—Simple, one-piece wire.
- Notched tie plates—Slip into place. Easily installed or replaced.

Roof brick recommended: CM-40R Cladex or other specified chrome and magnesite compositions.

6 HEARTH CONSTRUCTION

- Monolithic subhearth—Formed by Subhearth Kromform. Easy to install. Perfect conformation.

Brick recommended for inverted arch bottom: Porter M-90B, or other specified chrome and magnesite compositions.

Ramming mix recommended for working bottom: Porter Magnaram 95 for highest MgO content. Or Magnaram 85.

Brick recommended for back wall: MC-70 Cladex. Also other burned and unburned chrome and magnesite compositions.

Brick recommended for front wall: MC-70 Cladex in standard and special jamb brick. Also available burned or unburned chrome and magnesite compositions.

Announcing the Porter All-Basic Furnace—industry's most advanced all-basic open hearth roof

both suspension and refractories by Porter

It's here in detail . . . the Porter All-Basic Open Hearth!

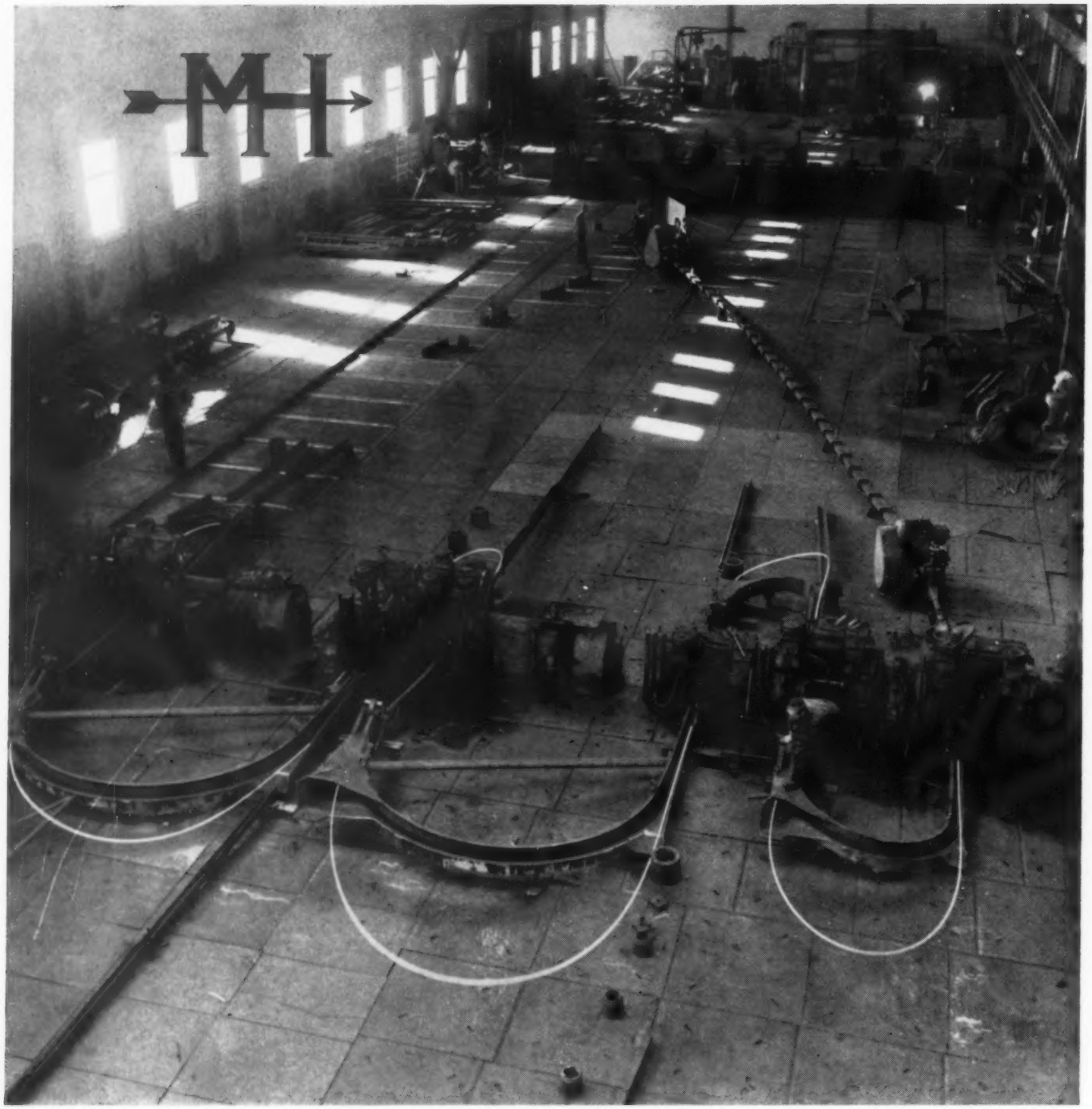
A new concept in roof and endwall suspension employing the present fundamental construction now in use. Both incorporate a new, *all-metal cladding* method to provide proper expansion allowance throughout the entire system.

The suspension system and the basic refractory materials are designed to work together . . . no guesswork regarding either. There is no division of responsibility; Porter is your complete source.

For more information write *Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

REFRACTORIES DIVISION PORTER **H.K. PORTER COMPANY, INC.**

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; PEERLESS ELECTRIC DIVISION; Specialty Alloys—RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRACTORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H. K. PORTER COMPANY de MEXICO- S. A.; and in Canada, Refractories, "Disston" Tools, "Federal" Wires and Cables, "Nepcoduct" Systems—H. K. PORTER COMPANY (CANADA) LTD.



Combined Rolling Mill for medium and small sections and wire rod

Morgårdshammar Combined Rolling Mills for high grade steels are designed to give closest possible tolerances and to allow the rolling of a large assortment of dimensions and sections, from 5 in. down to about 5/16 in. round.

For further information, please apply to us for reprints from the Journal of the Iron and Steel Institute.

Swedish Quality

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK. VERKSTADS AB • MORGÅRDSHAMMAR

Save coke . . . melt hotter iron . . . Hot Blast will do this for you! Whiting Hot Blast gets more heat out of coke . . . ignites it faster. Tuyeres keep clean and unobstructed, provide better control of melt. Oxidizing zone is reduced and oxidation losses are cut. And less coke means less sulphur in the melt!

Hot Blast more than pays for itself in *coke savings alone!* Better quality, hotter iron are bonus benefits. Investigate Hot Blast now. Call in a Whiting Foundry Engineer!

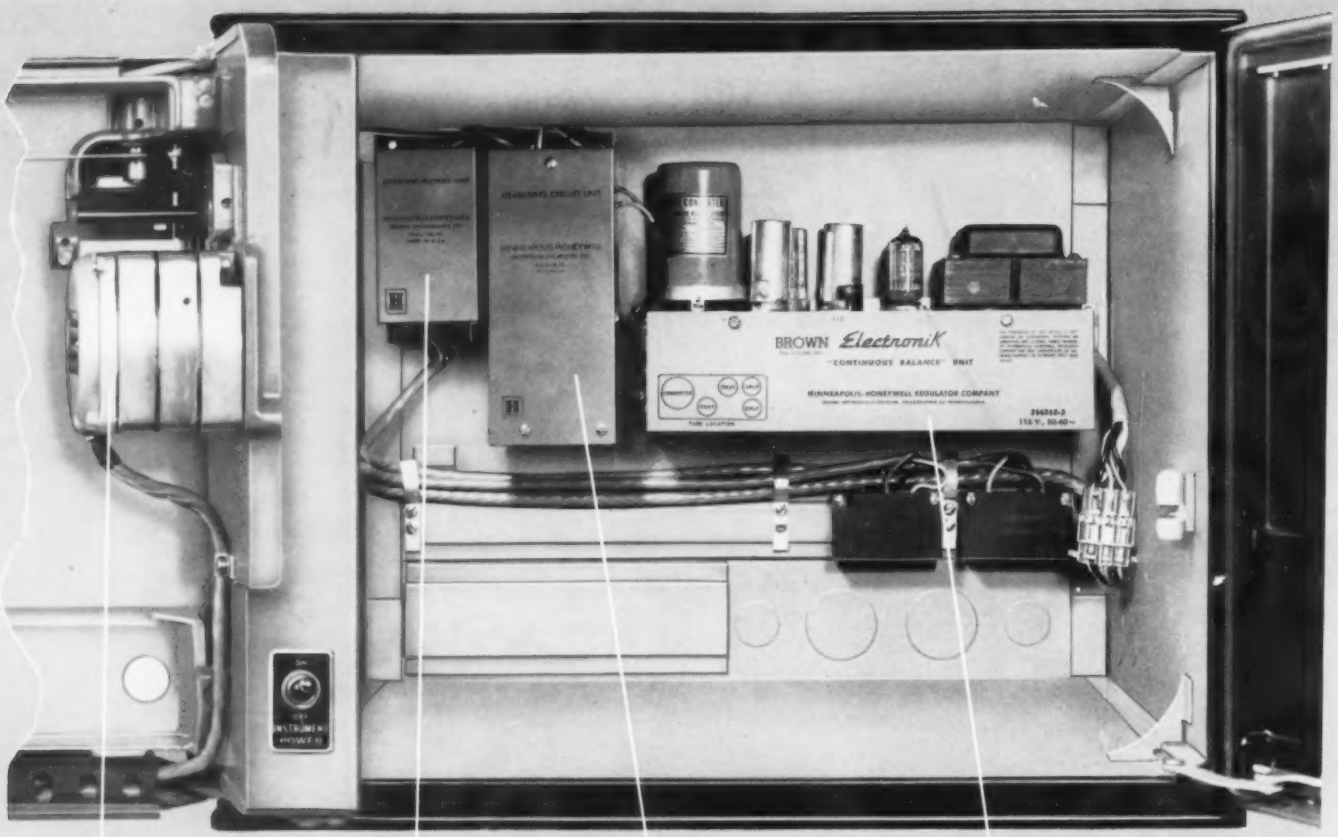
FREE BOOKLET . . . Gives sharp insight into Hot Blast advantages; describes operation of two major types. Write for Bulletin FO-3. *Whiting Corporation, 15655 Lathrop Avenue, Harvey, Illinois*

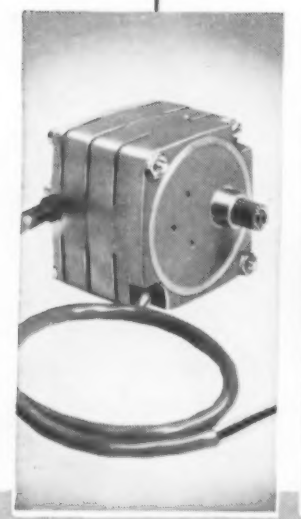
COST-SAVING EQUIPMENT.. THE WAY TO HIGHER PROFITS

FOUNDRY EQUIPMENT

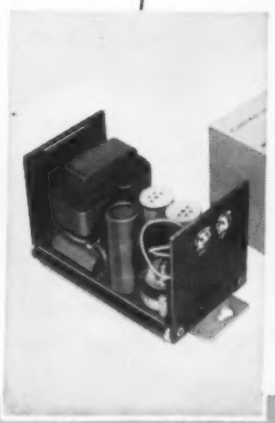
WHITING

MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY, RAILROAD, AND SWENSON CHEMICAL EQUIPMENT

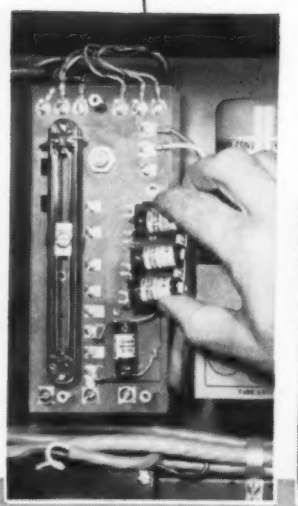




Servo Motor has sectional housing, leakproof oil-wick, printed circuits for simplified servicing. Any major part can be replaced in 2 minutes.



Constant Voltage Module —Uses Zener diodes and an ambient temperature compensator to replace standardizing mechanism.



Measuring Circuit Module—Contains easily-changed range spool panels and vernier adjustment. Range is changed simply by replacing screw-clip panels of fixed resistors.

Amplifier Module—Quick-connect design permits fast, easy removal for servicing and replacement. Circle shows quick connect plug.

THESE FOUR NEW FEATURES ARE STANDARD WITH ALL *ElectroniK* POTENTIOMETERS

New modular design...

makes ElectroniK potentiometers easier to use and maintain

Now, four great new features add new operating and servicing ease to all *ElectroniK* circular and strip chart potentiometers.

- **New servo and chart drive motors are sectionalized so that any major part can be replaced in two minutes.**
- **A new constant voltage unit replaces batteries, standard cells and standardizing mechanisms.**
- **A new measuring circuit, with quick-change range spools, simplifies range changing and reduces stray pickup.**
- **A quick-connect feature lets you remove the amplifier for service and replace it quickly.**

Now, modular design is combined with the traditional precision of *ElectroniK* potentiometers, to give you a greater value than ever in accurate, dependable measurement and control.

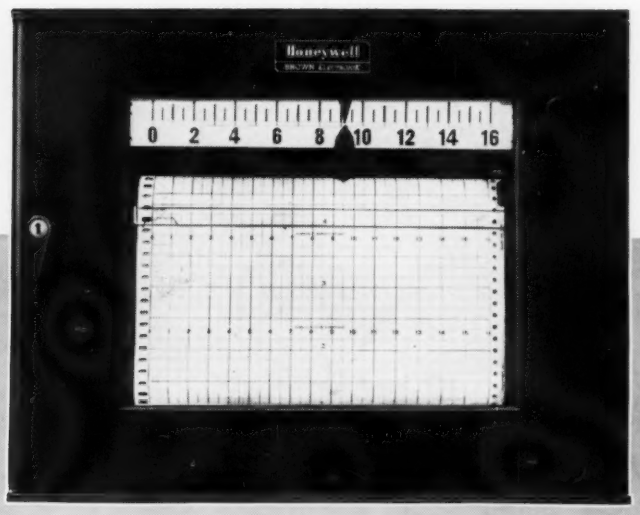
For full details, call your nearby Honeywell field engineer today. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

75th YEAR PIONEERING THE FUTURE

Honeywell

H HONEYWELL *First in Control* SINCE 1885



TRABON®

CENTRALIZED LUBRICATING SYSTEMS

1,000 bolts ahead with TRABON —each day!

There's nothing so terrifyingly quiet as a Boltmaker out of action. Yet to lubricate this Boltmaker by hand with its 26 grease points would take at the very minimum 10 minutes. That's equal to the time it takes to produce 1,000 bolts. Repeat this downtime for a month and you're talking big money. That's why you see a Trabon Centralized Lubricating System installed here to prevent lubrication shutdowns from taking place. Trabon delivers a measured amount of clean lubricant to all bearings — no matter where located. Trabon lubricates while the Boltmaker operates . . . eliminating downtime. Trabon saves man hours, bearing repairs, lubricant. No matter how large your machine — no matter how **new or old** — Trabon will help it produce more thus lowering your unit costs. Let us tell you more about how Trabon can improve the performance of your machines.

Digesting heavy wire and ejecting rugged high quality bolts is this National Machinery Boltmaker at an Ohio bolt manufacturing plant. A Trabon Manual Centralized Lubricating System (outlined in white) protects vital grease bearings by keeping them supplied with clean lubricant in exact measured amounts.

"Centralized" OIL AND GREASE SYSTEMS *"Meterflo"* CIRCULATING OIL SYSTEMS

Trabon® **Trabon Engineering Corporation** 28785 Aurora Road • Solon, Ohio

Equipment News...

MOTOR CONTROL CENTERS

△ Motor control centers with bus capacity from 200 to 2000 amp for voltages from 110 to 600 are available from Allis-Chalmers Manufacturing Co. The centers, offering improved operation, easier maintenance and increased versatility over individual units are used to control electrical loads such as motors, lighting, welding and heating in industrial plants and commercial buildings.

Available either as fusible or circuit breaker combination units, the control centers consist of two or more starters fed from a common bus and are often attached to transformers or switchgear to form a unit substation. Substations can be purchased as a complete package or as individual units. All control compartments of like size are interchangeable anywhere in the control panel.

Outstanding control center features that are of primary interest to users include: reduced engineering and installation cost; savings in floor space up to 33 per cent; versatility of unit through plug-in design which means that units can be easily moved from one location to another as needed; only one main circuit breaker is needed for one center; and equipment arrangement is neater, being centralized rather than spread out.

Maintenance needs are met easily because of the central location of the control center. Increased safety is afforded service personnel through mechanical interlocks on each door which shut off current when door to cubicle is open. Also, the new units have two doors for dual-mounted breakers which permits one breaker to be serviced without interruption to the other.

CARBIDE GUIDE ROLLERS

△ More than 80 per cent of maintenance costs have been eliminated on roller entrance guides on the finishing stand of a 9-in. wire mill for ¼-in. wire rod. Use of hard carbide guide rollers and bearings is solving this and other problems.

The cost saving is approximately $1.00 per operating hour, and annual saving is expected to be about $3600.

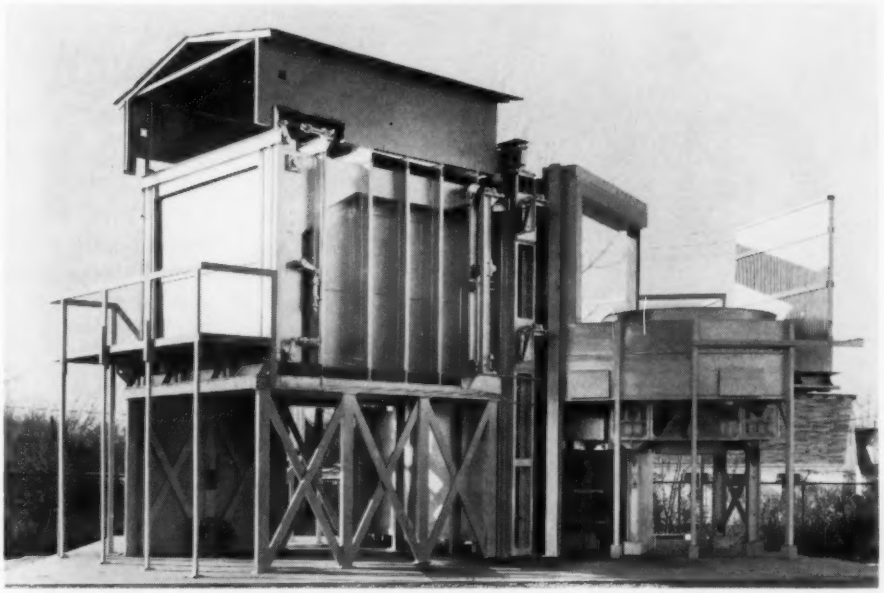
Life of the new guide rollers with unlubricated conical bearings is 20 times that of steel rollers with lubricated needle bearings. Average life of rollers was increased from four to 80 hr.

The quality of wire and rod was improved also by elimination of scratching.

The carbide rollers are made of Kentanium, a titanium carbide composition developed by Kennametal Inc., for use where high wear resistance is required at high temperatures. The conical bearing pins are made of Kennametal, a tungsten carbide composition. No lubrication is used or needed.

Former failures of guides were usually caused by needle bearing seizure, induced by high temperatures and lack of lubricant in the bearings. Steel rollers lasted four to 16 hr if allowed to remain in operation until complete failure, but preventive maintenance was preferable. On an average 40-hr rolling schedule, approximately 10 sets of guides (80 steel rollers and bearings) were used. Preventive maintenance required 20 man-hours for every 40 hr of production.

COMPANY ERECTS GIANT FURNACE MOCK-UP



The Lee Wilson Engineering Co., Inc., recently completed an actual size segment, complete in all detail, of their new opened coil method of annealing. The mock-up, erected on a concrete pad adjacent to the company's offices in Cleveland, Ohio, is used for engineering and sales purposes.

INTERRUPTER SWITCH

△ A new, modified type HPL-C interrupter switch for high fault closing requirements up to 40,000 amp has been announced by the Greensburg Division of I-T-E Circuit Breaker Co.

Design features of the switch

Get real value in lifting magnets from STEARNS

STEEL-MILL APPROVED

Red hot billet handled with ease by Stearns 65-in. circular lifting magnet capable of lifting up to 65,000-lb loads

Stearns value means highest performance and durability at the lowest cost

Stearns *value* is backed by 50 years of service to the steel industry.

Standard circular or rectangular magnets are available in either bolted or all-welded styles, in a wide range of capacities and sizes:

Circular — standard duty, 4 coil magnets — 20" to 77" dia.
deepfield, 6 coil magnets — 55" and 65" dia.

Rectangular — 9"x 24" to 26"x 80"

Whatever your steel-handling problem, Stearns engineers have the answer with built-in value.

Check these features:

- Deep-ribbed case for cooler, more efficient operation.
- Magnetic field design provides superior perimeter lifting power.
- Bronze "shock absorber" coil cover for additional protection against shock and jars.
- Waterproof construction.
- Permanently sealed magnet coil with vacuum-impregnated windings.
- Special laminated mica insulation provides extra protection against shorts, burn-outs and current leakage.
- Leads and terminals fully protected against abrasion and shock.

Call in your local Stearns representative for a job-studied recommendation and price quotation, or write for Bulletin No. 35CJ.

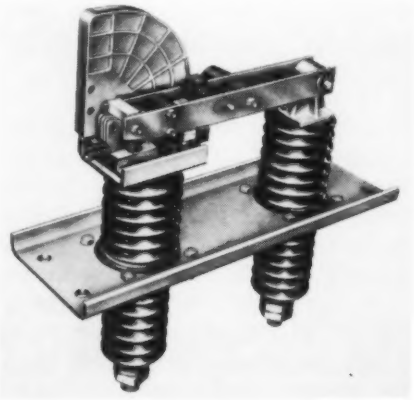
STEARNS MAGNETIC PRODUCTS

DIVISION OF INDIANA GENERAL CORPORATION • VALPARAISO, INDIANA

635 SOUTH 28TH STREET • MILWAUKEE 46, WISCONSIN

Profit with Stearns — Pioneer Builder of Lifting Magnets

include new spring-loaded, heavy duty, self-alining silver-plated stationary main contact fingers; heavy, silver-tungsten tipped, hard drawn electrolytic copper blades; heavy, silver-tungsten tipped, moving

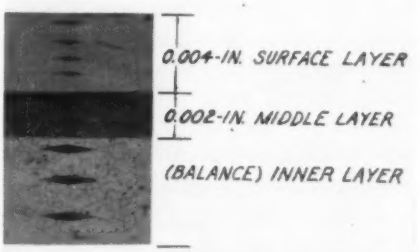


and stationary arcing tips; special blade guide; and extra heavy, formed steel base.

Ratings are listed as 600 amp continuous and 40,000 amp momentary. Test reports are available showing closing operation on 40,000 RMS amp asymmetrical, at 14.5 kv.

ALUMINIZING PROCESS

△ A new improved furnace-bond aluminizing process developed especially for high temperature service applications has been announced by Stainless Processing



Photomicrograph of Type 316 stainless steel aluminized by Wall Colmonoy process. The specimen was mechanically polished and electrolytically etched with 10 per cent oxalic acid. Diamond-shaped microhardness traverse shows relative hardness in different constituents.

Division, Wall Colmonoy Corp. It is recommended for application on any Series 400 stainless steels, all carbon steels and a variety of alloy steels. It also may be used with austenitic stainless steels.

The aluminum coating is applied cold by means of mechanical spray equipment. It is furnace-bonded to the base metal at high temperatures in a controlled atmosphere;

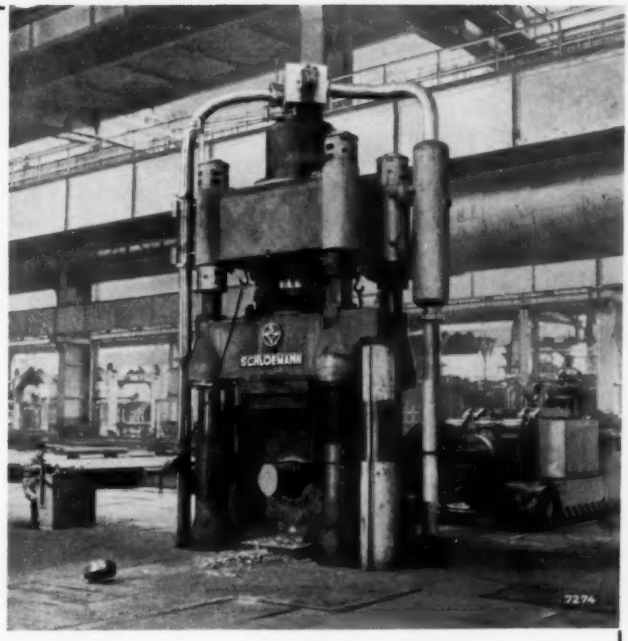
FELLER ENGINEERING

presents

SCHLOEMANN

Automatic controls for quick forging

The advantages of the welded construction of SCHLOEMANN quick forging presses of the open gap and four-column types have already been discussed in former publications. In the following, certain data are given on the quick forging equipment of a welded press having a power of 1,000 m.tons which also apply to other SCHLOEMANN quick forging presses.*



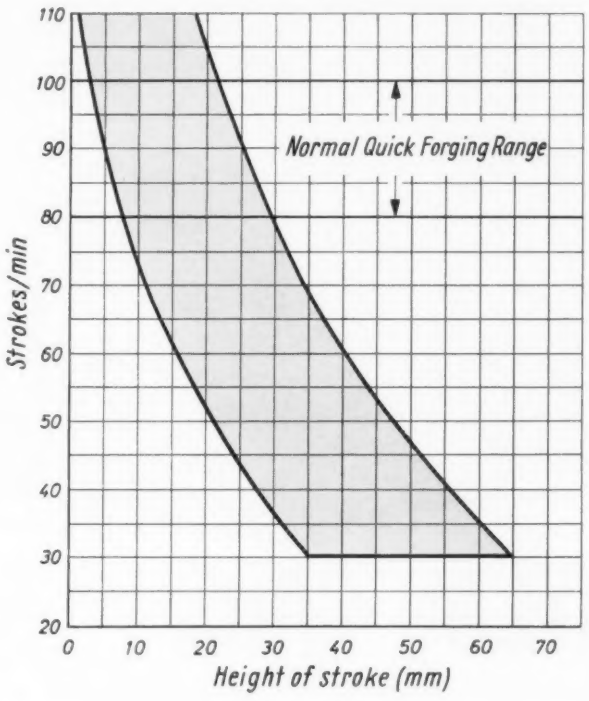
1,000 m.ton quick forging press with manipulator

Technical data

- Stroke adjustable (between ⅜ in. and 3⅛ in.) in ten to twelve stages by shifting the top dead centre during the automatic reciprocating cycle.
- Number of strokes adjustable (between 20 and 100 per min.) in ten to twelve stages with constant stroke through variable holding times at top dead centre during automatic reciprocating cycle.
- Precision adjustment of work level with constant stroke by shifting the top and bottom dead centres during the automatic reciprocating cycle.
- Coarse adjustment of work level through an intermediate stroke with automatically interrupted reciprocating cycle.
- Adjustment and regulation during automatic quick forging.

Operational advantages

These possibilities of adjustment assure good adaptability of the press to any forging problem. Because the smallest reciprocating stroke required for planishing can be adjusted, and because the number of strokes can, without varying the stroke, be adapted to the idle times required for moving the piece, power water consumption is low. When forging with the manipulator, the latter determines the operating cycle, i.e., the maximum number of strokes. Due to the exactitude of the quick forging control, only small machining allowances are needed. This is a prerequisite for a high production of forging pieces having close tolerances.



This work diagram of the quick forging press shows the number of strokes in dependence of height of stroke. In the indicated range, the number of strokes possible is determined by temperature, depth of penetration and effective width of the forging saddle.

* In 1957/1958, eight presses were fitted with SCHLOEMANN quick forging controls.

FELLER ENGINEERING CO., 1161 EMPIRE BUILDING, PITTSBURGH 22, PA.

the furnace-bond method achieves a desirable diffused alloy bond which is possible only at the high processing temperatures used. High temperature processing also provides the coating with superior properties of oxidation, corrosion, abrasion and erosion resistance. Total build-up is held within the tight range of 0.002 to 0.005 in.

Advantages claimed for the new method are:

1. More uniform coating in all areas; this refers to thickness, penetration and microstructure (see photomicrograph).

2. Deeper penetration; deeper, denser alloy layer provides higher oxidation and corrosion resistance.

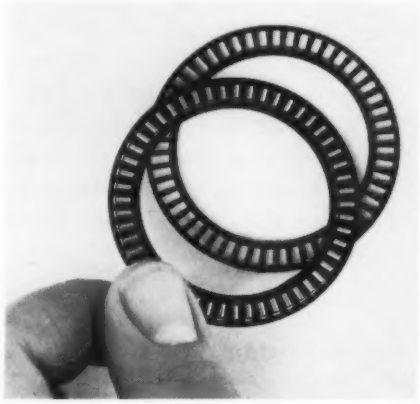
3. Greater hardness, giving better abrasion and erosion resistance; makes process more suitable for applications involving exposure to high velocity hot gases.

4. Better control of dimensional change due to build-up and growth; this results from the tight 0.002 to 0.005-in. build-up range.

NYLON BEARING CAGES

△ Glass-filled nylon is being used in the manufacture of cages for thrust bearings. A product of the Garlock Packing Co., the cages are available for either roller or ball bearings and in a wide range of sizes.

Chief advantage of using glass-filled nylon is that tramp metal invading the bearing area imbeds itself into the plastic. This imbedment removes ordinarily loose metal particles from circulation, greatly reducing bearing abrasion and consequent wear of adjoining metal surfaces. If the bearing cage should fail, the problem of metal particle entrainment is obviated.

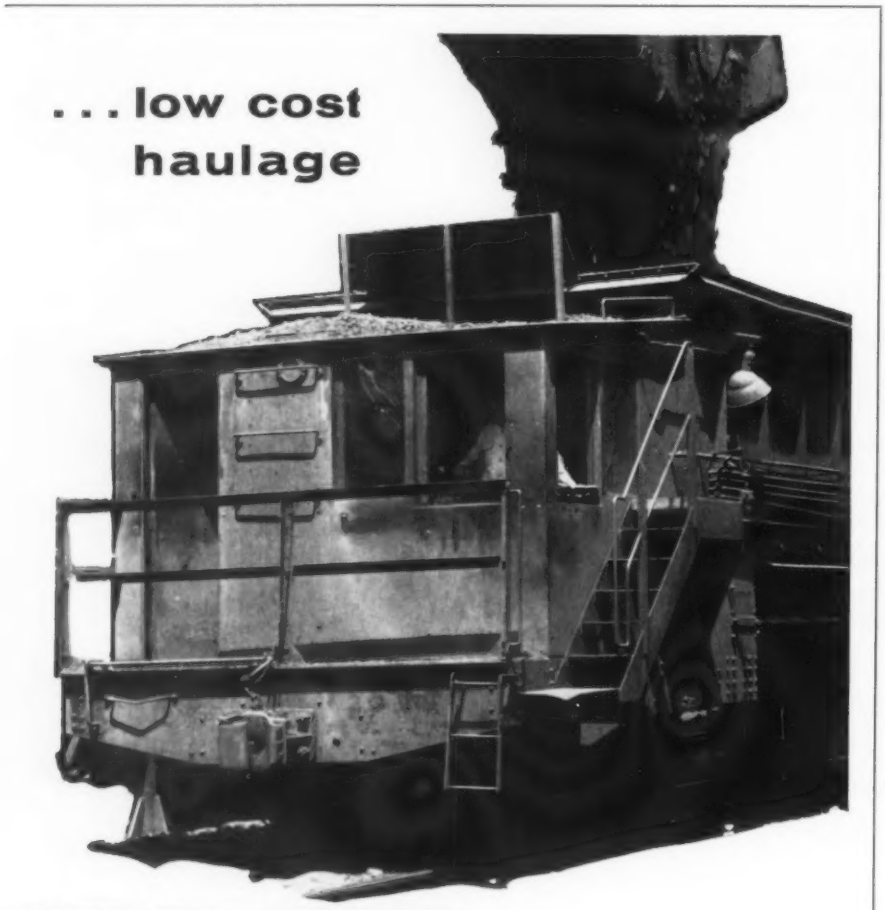


Other paramount gains attendant with the use of glass-filled nylon are the significant reduction of assembly time and initial material cost savings. Molded-in retention cavities firmly position and hold round or shaped bearings, which are simply popped into the receptacles. The material has excellent wear resistance, and in itself requires no lubrication, affecting savings in maintenance and downtime. Superior wear qualities and a wide temperature service range assure smooth, unhampered operation and greater bearing life.

D-C CRANE CONTROL

△ Type "PT" crane control, introduced last year by EC&M Division of Square D Co., now features self-contained undervoltage and overload protection. It provides full magnetic control on any d-c application up to 55 hp, 230 volts.

Heavy-duty components throughout make Type "PT" control suitable for mill accessory drives as well as light industrial cranes. The compact controllers are front-connected for mounting against



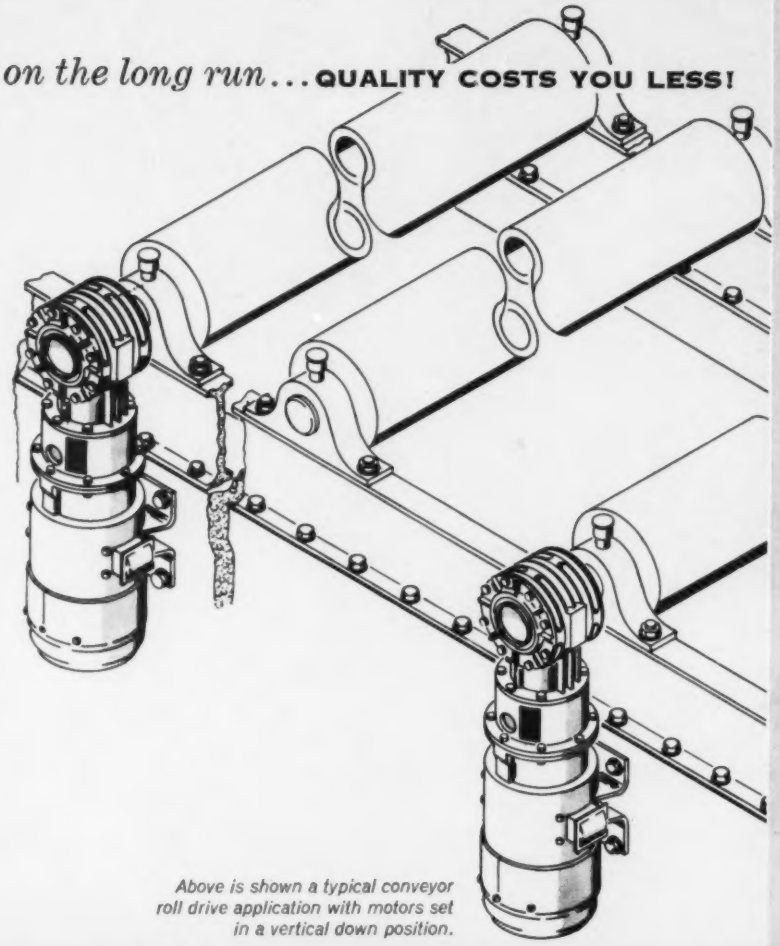
ATLAS CARS

Custom-built to the needs of each customer, Atlas Cars assure the dependability that maintains haulage schedules.

Since 1896 designers and producers of Ore Transfers . . . Scale Cars . . . Coke Quenchers . . . Coal Larries . . . Door Machines . . . Safety-Type Transfers . . . Storage Battery Locomotives

ATLAS CAR & MFG. COMPANY
1140 IVANHOE ROAD
CLEVELAND 10, OHIO

on the long run... **QUALITY COSTS YOU LESS!**



Above is shown a typical conveyor roll drive application with motors set in a vertical down position.

Flange mountings or all-motor base plate available to meet your requirements. Cast gray iron or steel housings available. Shaft sizes with "Celeron" bushing, maximum bore: 3-5/16"; without "Celeron" bushing, maximum bore: 4".

Gear Locking eliminated in this

WESTERN GEAR CONVEYOR ROLLER DRIVE

This shaft mounted conveyor roll drive was originally designed and manufactured for use as a sink roll drive in steel mill tin plating lines. Since this original unit, a considerable number have been sold in the steel industry for related uses. The unit contains a single reduction spiral bevel gear set. This is the secret of the no-locking feature, that eliminates costly down time. Gear teeth are hardened for maximum life. Heavy duty bearings are used to support all gearing loads. Horsepower ranges are normally from 2 to 5. Any motor to 1800 RPM can be used.

WG INDUSTRIAL PRODUCTS DIVISION

FACTORY OFFICES AND REPRESENTATIVES IN PRINCIPAL STEEL INDUSTRY CENTERS, INCLUDING CHICAGO, CLEVELAND, PITTSBURGH, BIRMINGHAM AND NEW YORK.

Contact the Western Gear representative in your city, or write

WESTERN GEAR CORPORATION

Industrial Products Division

P.O. Box 126 • Belmont, California

Loewy 1500-ton fast forging press in operation

Optimum output, ease of operation, high accuracy... all go with LOEWY free-forging presses

Designed for faster displacement of metal with fewer reheats, Loewy free-forging presses feature modern control systems that permit instantaneous selection of all the working cycles required for most efficient and accurate operation.

For normal forging and fast planishing, the operator controls the press without effort by a single hand lever through a sensitive oil-hydraulic servo control. With automatic operation, pushbuttons are used for either single or repeated strokes. Signals for reversal of press are transmitted to receivers on the operating pulpit by industrial-type electronic devices. All adjustments—stepless or incremental—for working level and for length of stroke and number of strokes per minute (up to 100) are made at the operating pulpit only. Automatic reciprocating control improves output, saves high pressure water, increases accuracy and prevents operator fatigue.

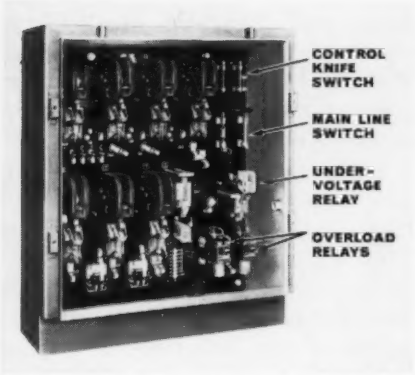
For detailed information on how Loewy-Hydropress free-forging presses can help solve your production problems, write Dept. C-2.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

BALDWIN BLH LIMA-HAMILTON



walls or girders, fit easily in cabs, on crane walkways or wherever space is limited. The exclusive Wright dynamic lowering circuit used in "PT" control gives maximum hook speed without danger of overspeeding. Automatic acceleration relays are adjustable from 0.2 sec or more per step.

"PT" control is also supplied without protection for use with separate protective panel. Available in NEMA Type 1 general purpose, Type 1 gasketed or NEMA Type 3 enclosures.

SQUIRREL CAGE MOTORS

Δ New high-speed squirrel cage induction motors are now being offered in 100–5000 hp, 514–3600 rpm, frames 584-11,320 by the Ideal Electric and Manufacturing Co.

A one piece, wrap-around steel plate cover running the full length of the frame, extends well below the centerline of the motor on each side to provide natural drip-proof protection and to increase the rigidity of the frame structure. The

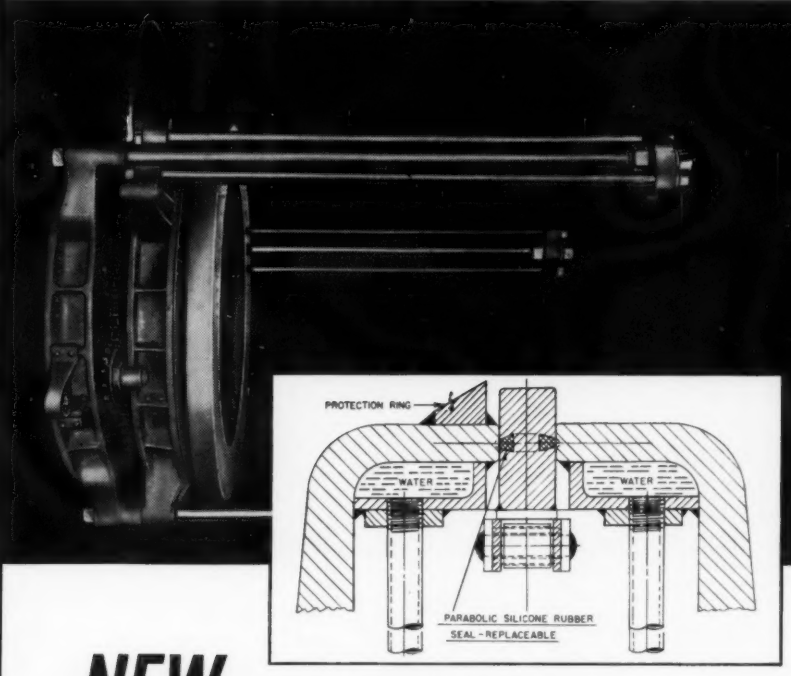
double end ventilation system provides maximum cooling, permitting full utilization of motor capacity.

Motors are available with silicone rubber as well as class A, B and H insulations.

Rotor and stator assemblies are

World's First

Water-Cooled, Silicone Rubber-Seated GOGGLE VALVE



NEW... GAS-TIGHT Service for High Pressure Furnaces

Designed for use between dustcatcher and washer, this valve features parabolic silicone rubber seats in the goggle plate, and water cooled flanges. Design provides a tighter, more gas-proof seal than is possible with metal-to-metal seals. *Write for Bulletin V-200.*

BAILEY *Thermal Expansion* GOGGLE VALVES

WILLIAM M. BAILEY COMPANY • 1221 BANKSVILLE ROAD • PITTSBURGH 16, PA.

precision manufactured of select materials and subjected to severe simulated-load tests for peak performance of any installation. Stainless steel retaining rings over rotor end assemblies give additional protection against stresses from centrifugal force where high peripheral speed is encountered. Critical speeds are maintained well above operating range to insure smooth, vibration free operation.

Patented oil lubricated bearing, supplied on squirrel cage induction motors provide unrivaled long life, cool operation and high load-carrying capacity. As a result of this feature plus the unique split-type bearing bracket, a valuable reduction in maintenance costs can be realized. Bearing replacement, when inspection proves necessary, can be accomplished without uncoupling the motor, disconnecting leads or disturbing motor or coupling alinement.

TINPLATE DATA SYSTEM

△ A completely transistorized data acquisition system for use in boosting quality control in the manufacture of tinplate has been developed by the General Electric Co.

First installation of the system—which records defects and determines the grade of tinplate coils—was at the Aliquippa, Pa., plant of Jones and Laughlin Steel Corp. where it has been operating successfully for about a year. Similar systems have since been installed by several other tinplate producers.

With the tinplate line operating at speeds up to 2000 fpm, the automatic inspection data accumulator (AIDA) simultaneously records information from a footage meter, strip thickness x-ray gage, pinhole detector, top and bottom coating thickness gages and a visual inspection station.

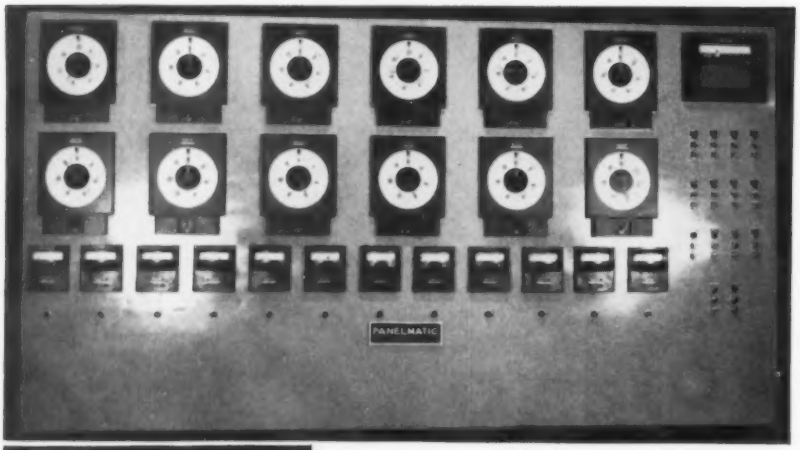
Output data provides a complete record of tinplate quality, including total coil length, length of prime, seconds and waste tinplate; and length of all defects detected in the coil. Upon completion of a coil, all data is correlated and summarized automatically. This summary information is fed simultaneously into an electric typewriter and card punch which provide permanent records for visual inspection or computer analysis.

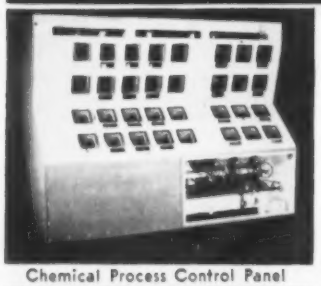
In operation, a pulse-type footage meter supplies basic length information to the system by giving one output pulse per foot of tinplate. When any of the inspection gages notes a defect, an electrical signal closes a transistor gate that triggers operation of a tachometer pulse counter. As long as the defect is present, tachometer pulses are counted and logged. Each successive occurrence of a defect adds to the previous count, engineers explained, thus providing a readily available cumulative figure at the completion of a coil run.

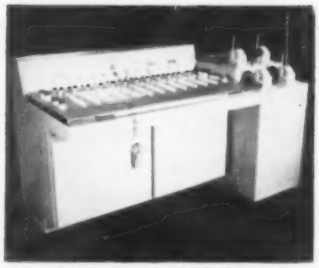
Logic circuitry classifies tinplate according to the defects detected by the highly accurate inspection system. The exact defect classification is flexible and can be set to various requirements.

When a coil is completed and the delivery end shear operates, information stored in the pulse counters is fed into a permanent transistor storage register. The counters automatically reset to zero well in advance of the next footage pulse produced by the new tinplate coil.

The coil is then transferred from the winding reel to a scale where weight data is electrically transmitted to the AIDA. This is printed out by the electric typewriter and punched into standard business machine cards along with other information previously recorded.




Chemical Process Control Panel


Steel Mill Auxiliary Benchboard

Motor Control Center

Complete, Custom-built Electrical, Pneumatic and Hydraulic CONTROL PANELS

We have complete metal working facilities to build the special enclosure. We regularly mount the components along with wiring and piping to meet all standards and specifications.

WRITE PANELMATIC, INC. 571 ANDREWS AVE. YOUNGSTOWN 2, O. FOR BULLETIN P-100A.

PANELMATIC

YOUNGSTOWN, OHIO

Predictable Performance

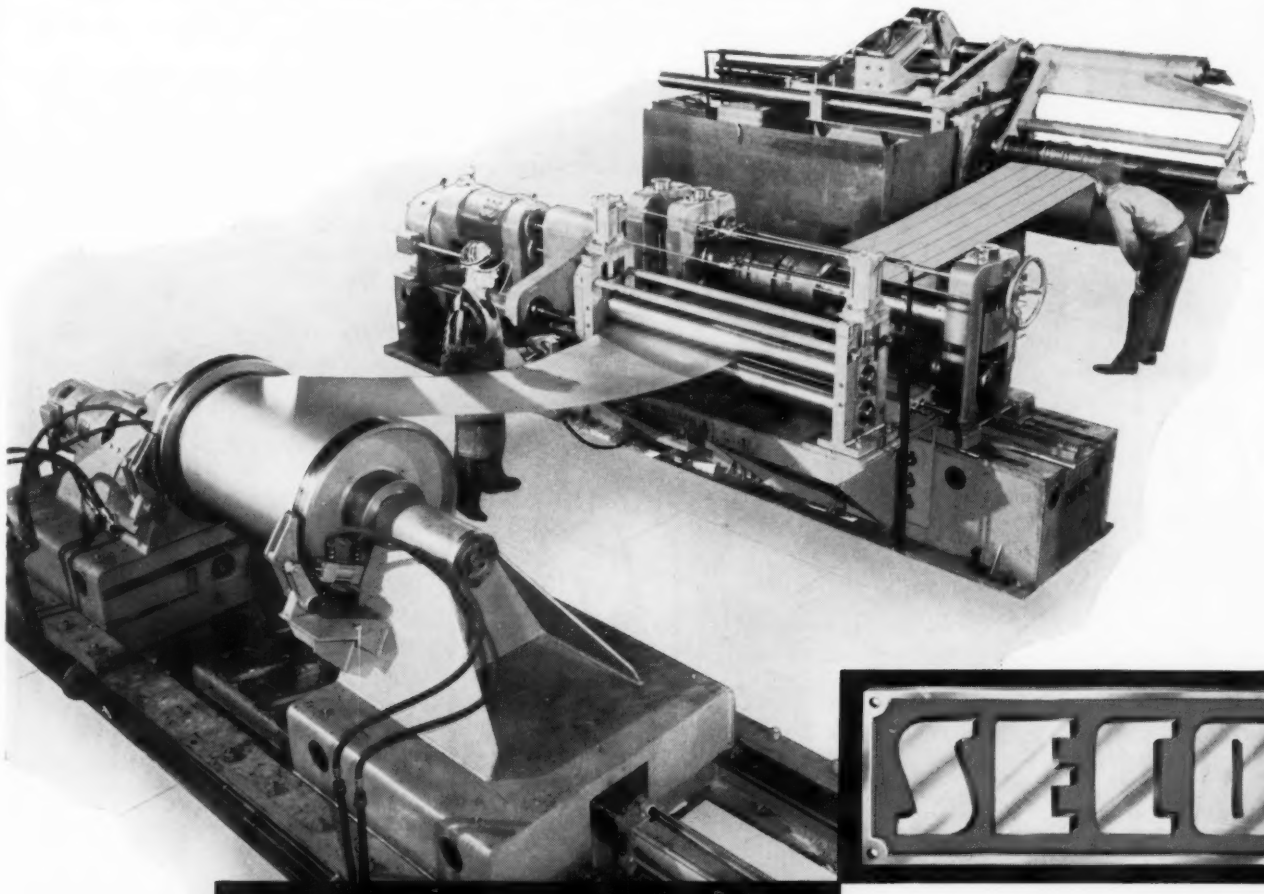
...is assured
Detroit Steel Corporation
with the installation of a

SECO **60" SLITTING LINE**

Availing themselves of SECO's facilities for custom building efficient slitting lines, the Detroit Steel Corporation, Detroit, Michigan, just recently installed this 60" Seco Slitting Line thereby assuring predictable performance. The entire unit, consisting of a cone-type Uncoiler, Slitter and Recoiler, was specifically designed and built by SECO for this customer.

Whatever your present requirements may be, call upon SECO's staff of trained sales engineers to assist you in planning for the present as well as your 'future' capacity.

Seco builds a complete range of slitting lines available from 12" to maximum strip widths.



STEEL EQUIPMENT COMPANY

P. O. BOX 737, WARRENSVILLE STATION
CLEVELAND 22, OHIO

SECO

SECO STEEL MILL EQUIPMENT

- Leveling and Shearing Lines
- Combination Edging and Flattening Lines
- Tension Reels for Strip Polishers
- Narrow Strip Grinding Machines
- Slitting Lines
- Multiple Strand Pull-out Rolls and Take-up Frames
- Strip Coilers (Up and Down Type)
- Traverse Reels for Narrow Strip
- Steel Coil Up-enders
- Scrap Ballers

Affiliated with Lee Wilson Engineering Co., Inc.

"Sure it's a great idea but we were only using 26% of it!"

"We've had the Payroll Savings Plan for U.S. Savings Bonds in our outfit for years. We think it is good for the Country and good for our company—and it goes without saying it's good for the saver. I had assumed we had a large participation by our people. But when I checked up last month I found that only 26% of our employees were regular users of the plan. In a company our size there is always a certain amount of personnel turnover, and there are always some people who are going to subscribe . . . next payday, maybe.

"So what I did was contact our State Savings Bonds Director. He helped us put on a company-wide campaign that reached every employee personally to point out the advantages of buying new 3¾% Savings Bonds, *regularly*. Today we have more than 50% of our people using the plan, and we're going on from there!"

Perhaps *your* organization, too, has been taking your Payroll Savings Plan for granted. It's a great idea, but its value to your people and to your company increases with the number of employees who use it, *every payday*. Let your State Savings Bonds Director show you how easy it is to get your company back in the high value area of participation. Or write Savings Bonds Division, U.S. Treasury Department, Washington, D.C.

ALL U.S. SAVINGS BONDS—OLD OR NEW—EARN ½% MORE THAN BEFORE

IRON AND STEEL ENGINEER

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All controls are mounted in an enclosed, heavy-duty, mill-type panel. Temperature control for the equipment is provided by a standard air conditioner.

AIDA was developed jointly by General Electric's Computer Department, Phoenix, Ariz., and the Systems Application Engineering Section of the Apparatus Sales Division, Schenectady, N. Y.

ALUMINUM ROLLING OILS

△ Demands of the aluminum rolling industry for ways of maintaining quality while decreasing operating costs has resulted in the formulation of an improved aluminum rolling oil by the L. R. Kerns Co. "Kleen Strip" 485 is claimed to have a greater prime yield and to lower cost per ton while improving the mill run quality and annealing results.

Especially successful on aluminum sheet and foil, the oil does not require any other additives or chemical compounds and therefore offers simple usage and control. Critical "new solution" or "start-up" problems are eliminated and consistent quality of runs is assured.

Mill operation checks have shown that there is no appreciable depletion of the oil in plant filtration systems. This high recovery rate with less make-up additions required, results in lower over-all cost and more uniform and stable rolling oil results.

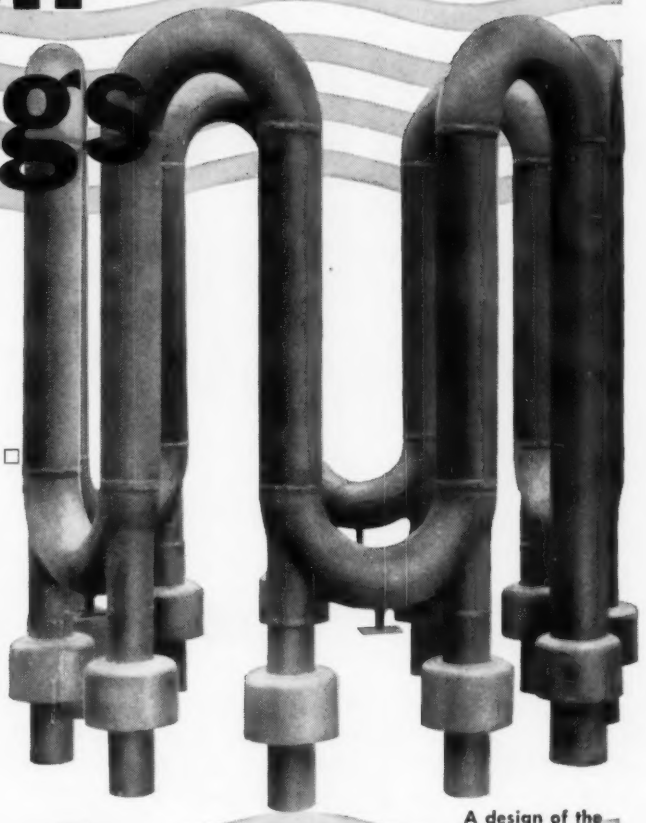
LEVEL-INDICATING UNIT

△ The Euclid Electric & Manufacturing Co. has announced their new Sen-Tek, light-sensing, level-indicating system.

This electronic light-sensing device detects and controls the level of opaque and solid materials. It detects levels of such materials as foundry sand, powdered coal, carbon, sugar, flour, salt and grain—or heavy, bulky materials such as stones, slag, coal, coke and ore. It installs easily on bins, tanks, hoppers, grain elevators, etc., as top-level and bottom-level indicators. It may also be used as either a top or bottom-level indicator or can be used as a limit switch, counter, indicating device or for similar applications.

The control requires no warm-up time, has no filaments to fail and does not lose sensitivity with age.

when things are HOT... call on Duraloy



A design of the A. F. Holden Co., Detroit, Mich.

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This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY... our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.

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Malleable Iron Unilet
Takes either 100 W or 150-200 W adapters. Ceiling, pendent, or bracket types available in a variety of hub sizes.

Reflector
Steel, with green porcelain enamel exterior; sized for 100 W, 150 W, or 200 W lamps. Snaps easily into position.

Unit Assembly . . . Adapter, Globe, and Guard
100 W and 150-200 W size globe adapter with shock absorbing socket. Die cast aluminum guard has two sealed stainless steel ball plungers which snap securely into cavities in adapter. Vaportight globe in 100 W or 150-200 W sizes in clear glass or various colors.

U. S. Pat. 2,749,433
2,749,435 2,715,214
Canada Pat. 531,655
511,696

For economical service and maintenance, it's hard to find anything more practical than Appleton's V-51 Series exclusive unit assembly (adapter, receptacle, globe, and guard). Shock absorbing socket cuts lamp replacement costs. Try the Appleton V-51 Series standard or shallow dome, deep bowl, or angle type reflectors and 100 W and 150/200 W vaportight unit assemblies in your plant today. Available in a variety of hub sizes in pendent, ceiling, or bracket type fixtures for every kind of installation.

Maintenance man takes spare assembly to lamp requiring replacement or wattage change . . . removes lamp assembly . . . screws fresh unit in place and the job is done! Higher wattages of 150/200 are interchangeable with 100 watt unit and can be used in same unilet body. (Die-cast aluminum guard turns counter clockwise to act as a tool for easy removal in relamping).

An upward thrust and slight quarter twist engages neoprene ring with the groove in the unilet and snaps the reflector in position. Entire operation of removing lamp, inserting new unilet, and positioning of reflector requires no special tools . . . no set screws . . . no small parts to juggle. Absolute simplicity!

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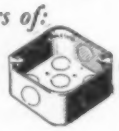
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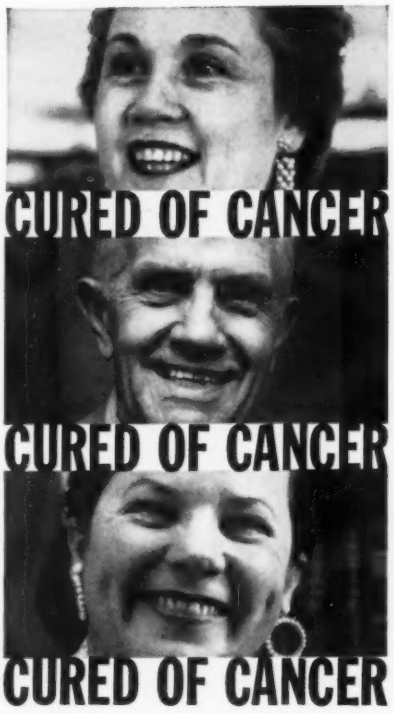

There are a million of them! Untold numbers of these men and women actually owe their lives to information they obtained from the American Cancer Society.

Fighting cancer is our business. We have all kinds of ammunition: posters; exhibits; film strips; easy-to-understand folders; hard-hitting, dramatic films.

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Call or write the Unit of the American Cancer Society nearest you. It's stocked with ammunition that could save *your* life.

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COMPACT LUBE SYSTEM

△ Trabon Engineering Corp., announces its new compact gun-operated system for centralized lubrication of small machinery or where space does not permit mounting a manual or automatic pump.

Up to 16 outlets may be handled from a single Type M assembly with outputs varying from 0.010 to 0.070 cu in. of grease per cycle. A cycle indicator, located on the side of the assembly, enables the grease-gun operator to cycle the assembly the correct number of times to give each bearing its exact amount of lubricant, positively and precisely. Since the measuring pistons operate in sequence, every bearing gets a full shot and any blocked line or bearing stops the cycle, "freezing" the indicator pin. This central warning feature enables blocked conditions to be corrected before the bearing is lost. Should it be necessary to keep the machine in production, removal of the test plug common with the blocked line will restore the system to normal operation.

Also available is a small strainer block with removable screen to prevent grit and dirt from reaching the bearings.

The gun-operated system eliminates the pump investment, yet provides all of the advantages of centralized systems.

SLAB GRINDING ECONOMY

△ A 26.8 per cent reduction in cost per pound of metal removed in stainless steel slab conditioning has been reported from recent grinding tests conducted by Simonds Abrasive Co. in the plant of a stainless steel producer.

These results were achieved, primarily, by using faster grinding wheel speeds than normal, but under carefully controlled conditions within the limits of safe grinding practice. Hot pressed snagging wheels were used because of their strong, dense construction and ability to withstand the higher grinding speeds, in combination with their fast abrasive cutting action.

Machine safety was provided by equipping a Midwest semi-automatic billet grinder with a special Fox Grinder head with design changes. A heavy duty guard was used with certain features on it which permitted covering as much as

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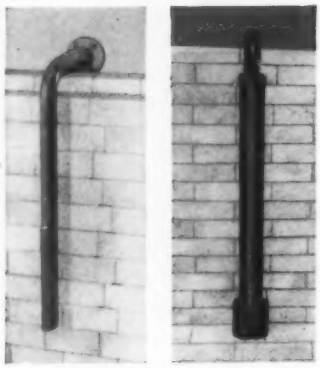
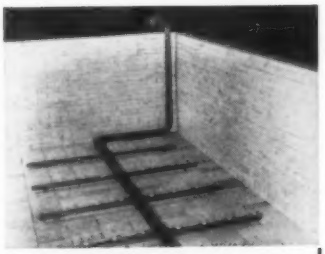


Heil Steam Jets for Continuous Pickling Applications



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70 per cent of the grinding wheel.

Grinding was done on 300 series stainless steel slabs 12 to 14 in. wide, 2 in. thick, lengths up to 30 ft. Grinding wheel size was 24 x 3 x 12 in. Grinding wheel speed was 12,300 surface fpm as compared with conventional speed of 9500 surface fpm.

The test in question is by no means conclusive, but points the way to major economies in the important operation of conditioning stainless and alloy steel slabs and billets in steel mills prior to rolling. It must be noted, however, that any such tests involving the higher grinding wheel speeds must be accompanied by adequate safety precautions.

DESCALING NOZZLES

△ Width of the over-all spray pattern of a descaling nozzle manifold may now be easily reduced in size to duplicate the widths of various strips that may be run in a hot strip mill. This adjustment is possible through the newly designed Spraying Systems Co. 8484-3/4 USSTC-E Descaling Nozzles with external threads on the outlet end of the body.

Stainless steel caps are supplied for capping any nozzles in a manifold that are to be shut off. Use of these new nozzles and caps results in material water saving when rolling narrower strips. The nozzles themselves are made of stainless steel with tungsten carbide orifice inserts, providing maximum possible resistance to abrasion.

The tungsten carbide orifices are made with a special "open" ellipse design that has proved successful in reducing clogging difficulties. Slot type strainers are supplied with these nozzles as optional equipment.

Book Reviews

"Reactive Metals—Metallurgical Society Conferences, Volume 2," edited by W. R. Clough, has been recently published by the Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. The book contains 610 pages, 6 x 9 in., is cloth bound and sells for $15.00. This book is the proceedings of the Third Annual Conference, sponsored by the Niagara Frontier Section, in co-operation with the Metallurgical Society, American Institute of Min-

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GIVE TO HEART FUND **FIGHT HEART DISEASE**

ing, Metallurgical, and Petroleum Engineers, conference at Buffalo, N. Y., May 27–29, 1958. The volume is comprised of the work of 66 contributors and papers cover the field of reactive metals. The discussions of the various papers are included. The text is amply illustrated with photographs, diagrams, tables and graphs.

"Quality Requirements of Super-Duty Steel—Metallurgical Society Conferences, Vol. 3," edited by R. W. Lindsay, has been recently published by the Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. The book contains 309 pages, 6 × 9 in., is cloth bound and sells for $8.50. This book is the proceedings of a Technical Conference sponsored by Physical Chemistry of Steelmaking Committee of the Iron and Steel Div., and Institute of Metals Div., The Metallurgical Society and Pittsburgh Section, American Institute of Mining, Metallurgical, and Petroleum Engineers, conference at Pittsburgh, Pa., May 5–6, 1958. The volume is comprised of the work of 21 contributors. The discussions of the various papers are included. The text is amply illustrated with photographs diagrams, tables and graphs.

"Physical Metallurgy of Stress Corrosion Fracture—Metallurgical Society Conferences, Volume 4," edited by Thor N. Rhodin has been recently published by the Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. The book contains 394 pages, 6 × 9 in., is cloth bound and sells for $13.00. This book contains a Symposium arranged and sponsored by Committee on Corrosion-Resistant Metals, Institute of Metals Div., The Metallurgical Society and Pittsburgh Section, American Institute of Mining, Metallurgical, and Petroleum Engineers, presented in co-operation with the Electrochemical Society, National Association of Corrosion Engineers, and the American Society for Testing Materials. The volume is comprised of the work of 29 contributors. The discussions of the various papers are included. The text is amply illustrated with photographs, diagrams, tables and graphs; many references are cited.

"Tool Engineering," by S. E. Rusinoff has been recently published by American Technical Society, 848 East 58th Street, Chicago 37, Ill. The book contains 326 pages, 8½ x 5½ in., is cloth bound, and sells for $6.75. This book explains tool engineering as practiced in manufacturing; each function of the modern tool engineer is explored, consulting with designers, studying costs, planning of processes of production, analyzing equipment and operations, selecting and improving equipment, developing operations. Economical production is stressed; analysis and comparison of costs necessary in selecting tools are covered; equipment and processes best adapted to the product and to the future plans of the manufacturer are discussed. Such areas as tool design, estimating, dimensions and tolerances and quality control, from the tool engineer's position are taken into account. Also pointed out are dangerous practices which must be avoided and handicaps which may

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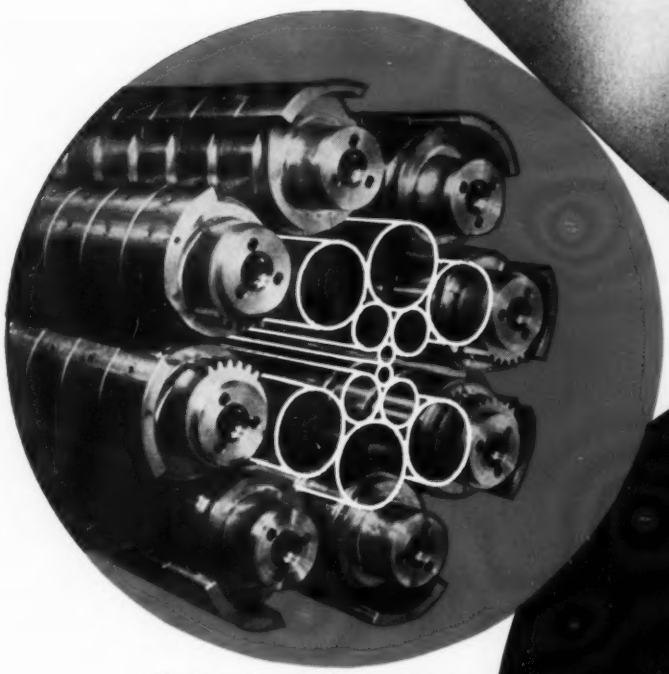

Phantom view of roll arrangement

This Sendzimir cold strip mill rolls 80" wide low carbon steel from hot rolled thickness to .024" with total gauge variation of .0004". Similar uniformity is being regularly obtained on Sendzimir cold strip mills rolling brass, copper, aluminum, stainless steel, silicon steel, etc.

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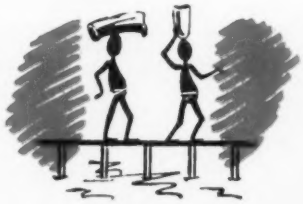


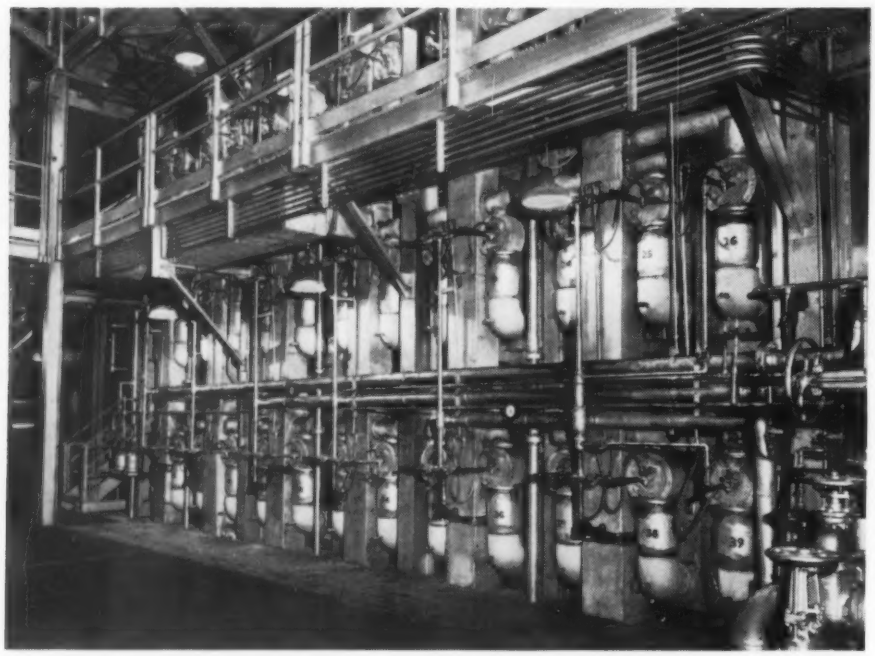
Sendzimir Support

be encountered. The book is illustrated with photographs, charts, diagrams, line drawings, equations, etc.

"Properties of Matter" (third edition) by F. C. Champion and N. Davy has recently been published by the Philosophical Library, 15 East 40th St., New York 16, N. Y. The book contains 334 pages, 6 x 9 in., is cloth bound, and sells for $10.00. The aim of the first edition was to treat matter from a physical point of view, and particularly to avoid regarding the material as exercises in applied mathematics. Newer and more accurate method for measuring various quantities such as the Newtonian Constant of Gravitation necessitated only brief reference to older methods, but classical work such as that of Boys has been fully described. The important changes in this new edition is not primarily the deletion or the addition of material as such but the gradual orientation of the subject from a largely phenomenological treatment to atomic interpretations.

"Modern Electronic Components," by G. W. A. Dummer, has been published recently by the Philosophical Library, 15 East 40th Street, New York 16, N. Y. The book contains 472 pages, 6 x 9 in., is cloth bound and sells for $15. This book, which presents a comprehensive survey of the characteristics of the more common components together with the arduous environmental conditions to which they are frequently subjected, also discusses component specifications, transistor-circuit components, reliability, future developments, etc. The selected bibliographies to many chapters provide the more important sources of specialized information. The book helps choose the most suitable component for a particular purpose. Numerous photographs, line drawings, tables, etc., amply illustrate and explain the text.

"Practical Design of Sheet Metal Stampings," by Federico Strasser has been published recently by the Chilton Co., 56th and Chestnut Sts., Philadelphia 39, Pa. The book contains 175 pages, 6 x 9 in., is cloth bound, and sells for $10.00. This book is considered an important step forward in knowledge of metal stampings. Stamping technique used in the pressworking of metals is based principally on practical knowledge, and the information presented here shows those factors in design of metal stamping which bring about economical and trouble-free production, also how this kind of production may be achieved by intelligent application of basic rules and concepts of stamping technique. Basic concepts, details of design and special problems from the basis of this study of the processes that transform sheet metal pieces or metal slugs into final products or product components. The book also contains 555 especially drawn illustrations.



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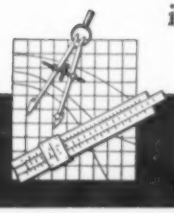

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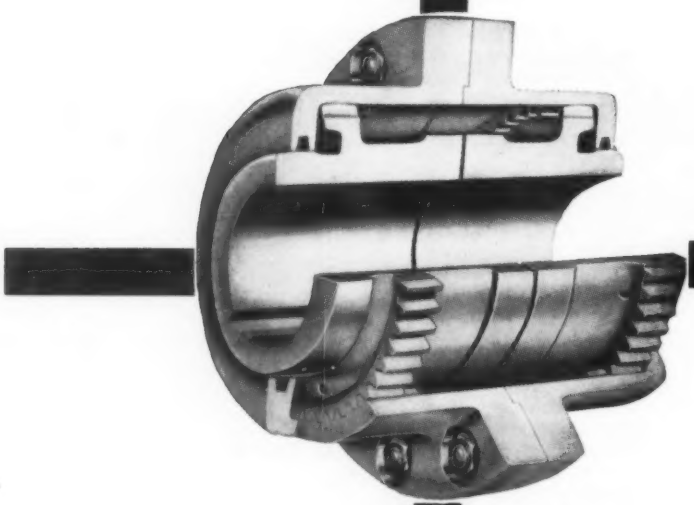

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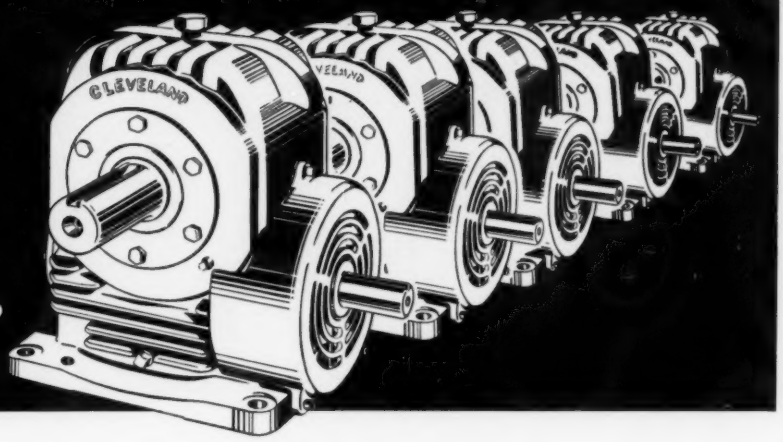

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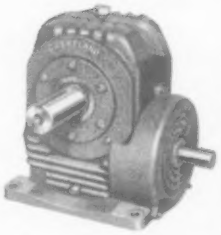

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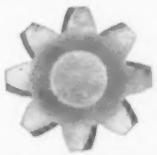

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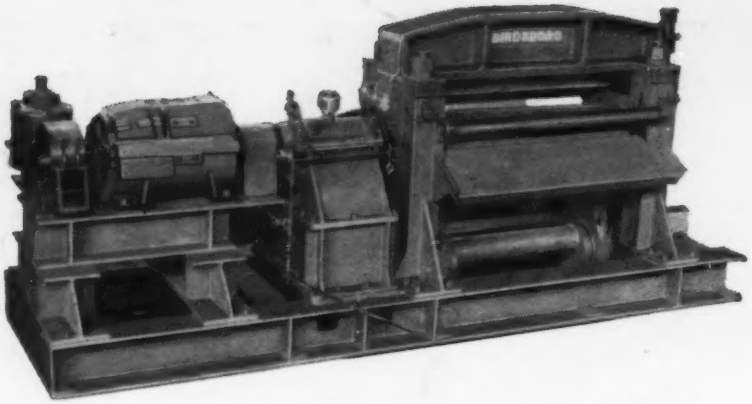

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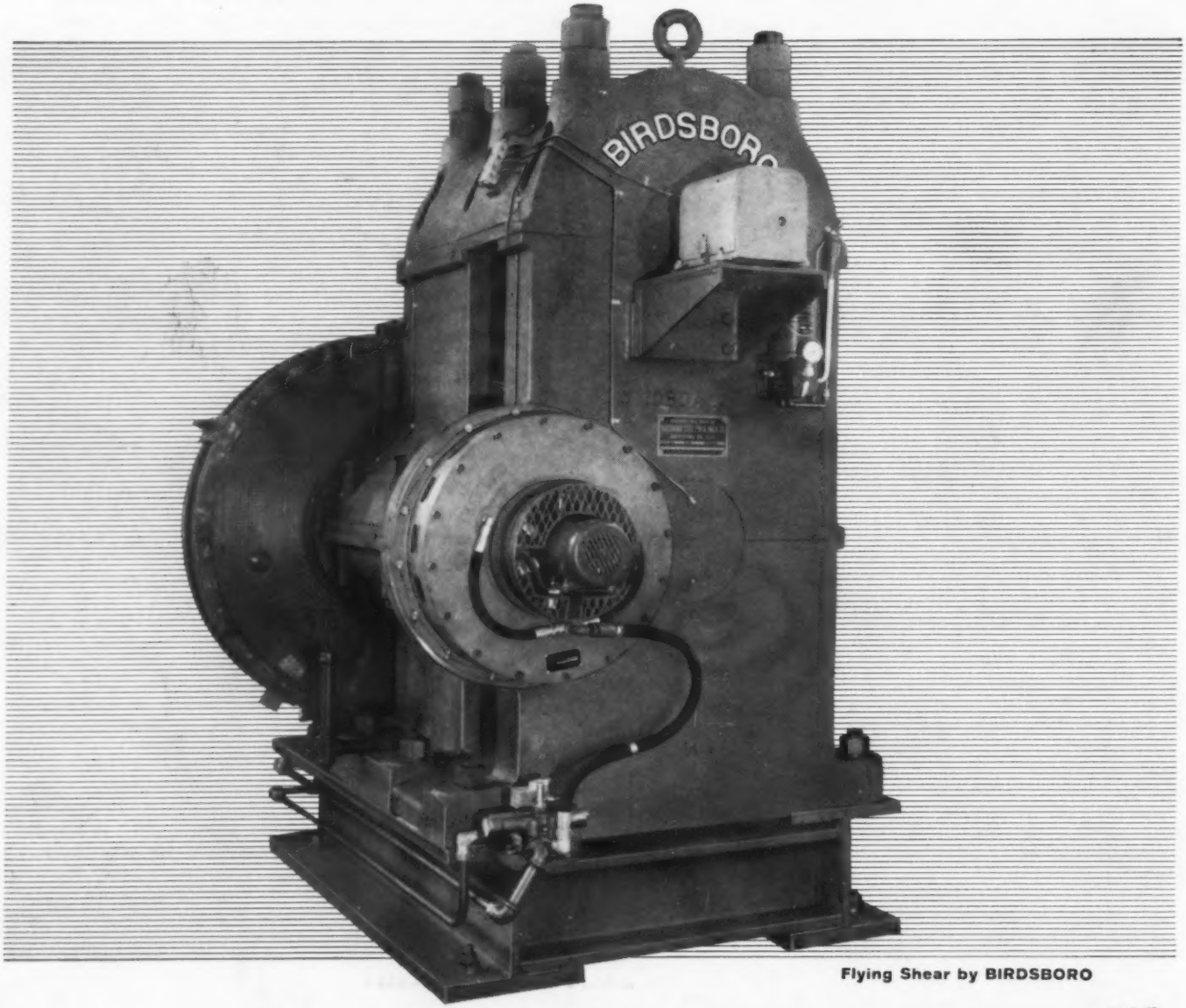

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